TREATISE

ON

MILITARY CARRIAGES

AND

OTHER MANUFACTURES

OF THE

ROYAL CARRIAGE DEPARTMENT.

BY

CAPTAIN W. KEMMIS, R.A.,

CAPTAIN INSTRUCTOR, R.C.D.

PRINTED BY ORDER OF THE SECRETARY OF STATE FOR WAR.

April 1874.





LONDON.
Printed under the Superintendence of Her Majesty's Stationery Office,
AND SOLD BY
W. CLOWES & SONS, 13, Charing Cross; HARRISON & SONS, 59, Pall Mall;
W. H. ALLEN & Co., 13, Waterloo Place; W. MITCHELL, Charing Cross;
LONGMAN & Co., Paternoster Row; TRÜBNER & Co., 57 & 59, Ludgate Hill;
STANFORD, Charing Cross; and HENRY S. KING & Co., 65, Cornhill:
Also by GRIFFIN & Co., The Hard, Portsea;
A. & C. BLACK, Edinburgh; D. ROBERTSON, 90, St. Vincent Street, Glasgow;
ALEX. THOM, Abbey Street, and E. PONSONBY, Grafton Street, Dublin.

Price Five Shillings.

CONTENTS.

INTRODUCTION.—MATERIALS.

PART I.—FIELD CARRIAGES.

SECTION I.—WHEELS AND AXLETREES.

SECTION II.—FIELD ARTILLERY CARRIAGES.

SECTION III.—SIEGE ARTILLERY AND MOUNTAIN ARTILLERY CARRIAGES.

SECTION IV.—ENGINEER, TRANSPORT, AND OTHER CARRIAGES.

PART II.—GARRISON CARRIAGES.

PART III.—NAVAL CARRIAGES.

LIST OF PLATES.

INTRODUCTION.—MATERIALS.

CHAPTER I.—TIMBER.

Growth. Where a tree is cut across we see in the centre the "pith," from which towards the bark rays, termed "medullary rays," extend. Between these rays the "woody fibre" is arranged in nearly concentric rings or layers ; each ring is the growth of a year, and hence the rings are termed "annular rings." The woody fibre is distinguished as "sapwood" or "heartwood," the former being the younger portion next the bark, and the latter the older and more compact portion inside.

Defects. Timber should be free from the following defects ; namely,—

"Shakes" or cracks radiating from the centre ; "cup shakes" or cracks between the annular rings; "upsets," where the fibres have been curled and crippled by compression, a defect particularly common and apparent in ash.

"Rind-galls" or wounds received in one of the older layers, when young, and over which the more recent layers have not grown, but have left, as it were, a recess to the wounded layer, which is filled in by bark.

"Dead knots," where a branch has been cut off and the root, which has been left, has decayed. "Hollow or spongy" places proceeding from decay.

Timber, particularly elm and ash, is also liable to be "doated" from lying in wet; this defect is not apparent until the log is sawn into planks, when it makes itself evident by the yellow colour of the wood in spots. Again, timber may be "cross-grained," but this does not constitute unsoundness, though it might cause its rejection for certain purposes.

Good timber, characteristics of. It may be taken as a general rule that a good specimen of timber will present the following characteristics; namely, the woody fibre will adhere firmly together, and when freshly cut it will show no wooliness, nor clog the teeth of the saw cutting it ; the freshly cut surface will be firm and shining, having a somewhat translucent appearance. A dull chalky appearance is a sure sign of bad timber ; in several specimens of the same timber, in general, that will be the best in which the annular rings are the closest.

British woods The chief British woods used in the Royal Carriage Department are oak, ash, elm, and beech.

Oak. Oak is the strongest, toughest, and most lasting, and hence is used where strength and durability are required. The best oak, when new, is of a pale brownish yellow colour, firm and glossy on the surface, with small regular annular rings and large hard medullary rays, termed, from their distinctness, "silver grain." Thick rings, many large pores, a dull surface and reddish hue are signs of weak perishable wood. Oak contains an acid which tends to corrode iron in contact with it.

Ash. Ash is a tough wood remarkable for its elasticity, which renders it so well adapted for shafts, handspikes, felloes, &c. Its colour is like that of oak, but lighter and more greenish, and its annular rings are broader. Ash does not stand exposure to the weather well, and when stored is very liable to suffer from worm.

Elm. Elm is a very cross-grained tough wood, and therefore little liable to splinter. It is also valuable for its durability under constant wet.

Beech. Beech is a hard strong wood, but will not stand exposure to the weather.

The following are the chief foreign woods made use of; namely, African oak, sabicu, teak, mahogany, and pine.

African oak. African oak is a very durable, hard, close-grained wood, stronger, heavier, and darker in colour than English oak, for which it is used as a substitute.

Sabicu. Sabicu is an exceedingly hard, heavy, and durable wood, and hence is used for surfaces on which there may be much rubbing action, or where durability is an object and weight not objectionable. Sabicu is grown in the West Indies ; it is of darker colour than African oak.

Teak. Teak is an East Indian and African timber ; it possesses great strength, toughness, and durability, but splinters readily. It resembles oak in colour and lustre, and has narrow and regular annular rings. Teak contains an essential oil which tends to preserve ironwork in contact with it, and also keeps the wood itself from the attack of insects. This wood is used for work sent to foreign stations.

Mahogany. Mahogany is of two kinds, that from Honduras, in Central America, commonly know as Bay mahogany, and that from Cuba and other West Indian Isles, known as Spanish mahogany. Mahogany is strong in all directions, very durable, and preserves its shape well under varying circumstances as to heat and moisture. Honduras mahogany is lighter in weight than Spanish, which is distinguished from it by having a white chalky substance in its pores.

Pine. Pine wood is soft, light, and elastic ; it includes several descriptions ; namely,—

"Pine proper," the produce of the Scottish fir grown in Norway, Sweden, Russia, and North America. It may be either red, yellow, or white. The yellow pine alone is used in the Royal Carriage Department, for the interior fittings of wagons ; it is a clean wood, softer and less durable than the next description.

"Deal" is either white or yellow, the former is the produce of the spruce fir. Yellow deal only is used in the Royal Carriage Department for ammunition boxes and the boarding of wagons.

"Larch," a strong and durable, but knotty timber. The only form in which it is used is as "uphirs," or small trees, for ladders, &c.

Deal sawn up is received under the denomination of "planks," "deals," and "battens," according to the respective width, namely, 11, 9, and 7 ins., to which is added the name of the place from which it comes. Baulks are square hewn logs. Spars are trees rounded off into poles.

Table. The following table gives a comparison of the various woods :—

Nature.	Weight per cubic foot.	Breaking Weight. Batten 2″ square and 50″ between supports. Weight applied at centre.			Deflection under statical weight of 560 lbs.
		A. Statical.	B. Dynamical.*	Ratio between A. and B.	
	lbs.	lbs.	lbs.	lbs.	ins.
Oak, English	47·35	1302	784	·602	·718
Ash	46·69	1176	1008	·857	·828
Elm	35·25	714	616	·862	2·000
Beech	45·50	1260	1064	·844	·625
Oak, African	57·04	1554	1232	·793	·570
Sabicu	59·96	1904	1120	·588	·468
Teak	41·51	1428	1008	·706	·656
Mahogany, Bay	33·00	1008	616	·611	·859
Mahogany, Spanish	51·07	1162	840	·723	·640
Pine, yellow	24·75	882	616	·698	·843
Deal, yellow	30·75	1064	728	·684	·718

* This strain was not strictly "dynamical," but one applied suddenly.

The contents of a log are computed, if oak, elm, or foreign wood, by square measure; if ash or beech by round measure, because in these the outer layers are sound and better than the inner. **Measurement.**

Round measure is thus taken :— $\left\{\frac{\text{mean girth in feet}}{4}\right\}^2 \times$ length in feet = contents in cubic feet.

Square measure thus :—mean width in feet × mean depth in feet × length in feet = contents in cubic feet.

Fifty cubic feet = one load.

Abatement on the contents of a log is always made for the defects which, as before mentioned, timber is liable to.

Seasoning timber is expelling, so far as may be, the natural moisture in its pores, and this may be done naturally or artificially. **Seasoning.**

Natural seasoning is simply exposing the timber when cut into planks to the air, sheltered, if possible, from the sun and from high winds. The time required for seasoning planks, as a general rule, is one year for every inch of thickness.

Artificial seasoning may be done either by exposing the timber in a chamber to a current of hot air or of steam. This manner of seasoning, though quick, is objectionable, as it renders the wood more short and brittle as well as less durable than if naturally seasoned. Elm suffers less than other timber by artificial seasoning, but even it should be partially seasoned naturally first.

After seasoning the plank is cut up into roughly-shaped or "half-wrought" articles. This is done as economically as possible in the following manner :—Patterns of the articles are laid upon the plank in the most advantageous way, care being taken that the fibre runs as much as may be in the proper direction for each particular article, and the form of each pattern traced by a "racer." The plank is then cut across wherever possible by a circular saw, after which the articles are cut out by a band saw. For further drying the half-wrought articles are stacked in sheds until required for use. **Conversion.**

CHAPTER II.—METALS.

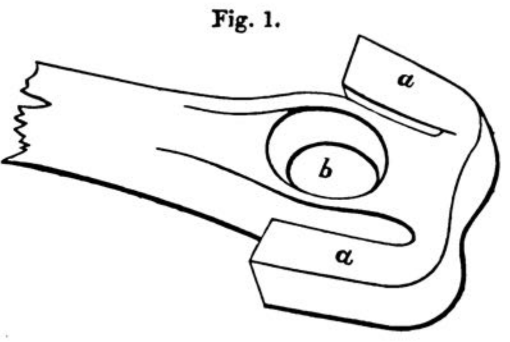
The chief forms in which wrought iron is received from contract are as girder, tee, angle, round, square, flat, and plate iron. **Iron, wrought.**

Scrap iron is produced in the Department and differs from best bar merely in having some of the fibres running across and not all in the direction of the length.

The quality of iron received from contract and its adaptability for any particular purpose is inferred from its behaviour under certain tests, for example ;

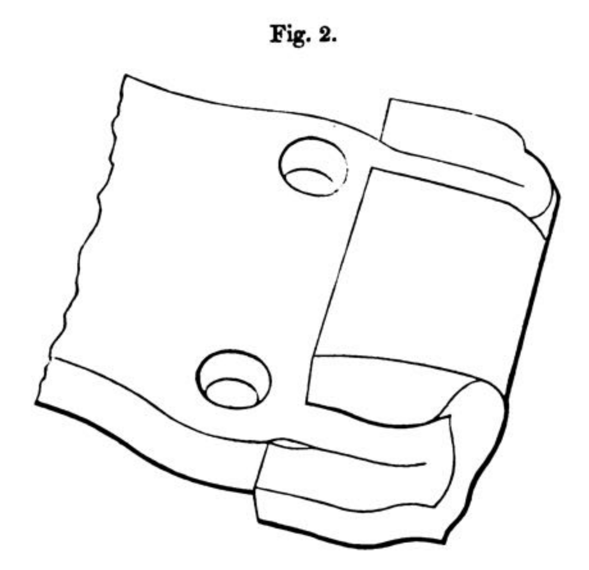
Round bar iron is tested hot by what is known as the "ram's horn" test, thus, a specimen is heated to rather less than welding heat, a hole punched through it near the end, the bar split from the hole to the extremity, and the horns (*a*, *a*, *Fig.* 1) so formed hammered back until they touch the sides, a second hole (*b*) is then punched

Fig. 1.



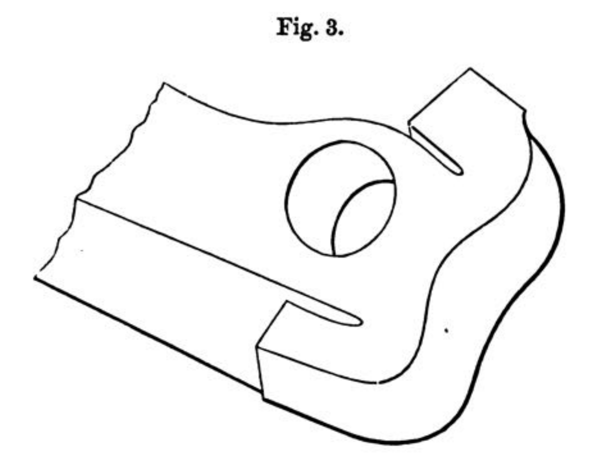
and enlarged until the sides bulge out; if the iron is good the fibre will not break either in punching the hole or in hammering back the horns. Round iron of small section is also tested cold by twisting it into a close loop; rivet iron, which is the most tough and ductile kind of round iron, should admit of being twisted into almost any form.

Fig. 2.



Flat and square bar iron are tested similarly to round iron by the ram's horn test, but in the former three horns are formed and two holes punched, *Fig.* 2, and in the latter, *Fig.* 3, one hole is made nearer to one side than to the other.

Fig. 3.



Large sized girder iron is tested hot by bending it at right angles when it should not crack nor tear at the tees.

Small sized girder iron, tee iron, and angle iron are tested by the ram's horn test as applied to flat iron; tee iron is also tested hot by hammering the tee down upon the sides, and angle iron by hammering the sides together.

Plate iron is tested by bending it on a cast iron slab with round edge when hot and when cold, both lengthways of and across the grain, to a

particular angle, when it should not fracture; the plate being cold, the angle is as follows:—

Plate			
Plate 1" thick,	bent with the grain 15°,	bent across the grain	5°
„ $\frac{7}{8}$"	„ 20°	„	5°
„ $\frac{3}{4}$"	„ 25°	„	10°
„ $\frac{5}{8}$"	„ 35°	„	15°
„ $\frac{1}{2}$"	„ 35°	„	15°
„ $\frac{3}{8}$"	„ 50°	„	20°

Plate of any thickness should admit of bending hot to an angle of 120° with the grain, and of 90° across the grain.

Both bar and plate iron should be able to stand a strain in the direction of the fibre of 22 tons per square inch, and plate a strain of 18 tons across the fibre.

Iron, malleable, cast. Malleable cast iron is a term applied to castings of certain iron, which by an after process of annealing are converted into a kind of steel. This nature of iron appears likely to supersede wrought iron and metal for certain small articles; it may be recognised by its toughness and by its refusing to weld.

Steel. Blister steel is tested as to quality by welding it on a piece of iron to form a chisel, hardening and tempering the chisel and then trying its edge by cutting a piece of iron. If the steel welds easily and keeps its edge it is of good quality.

Shear steel is also tested by welding it to a piece of iron to form a chisel, but the latter is tried by driving it into a block of hard wood.

Shear steel, in the form of spring steel, is not tested in this manner, but by curving a piece, tempering, and then compressing it until straight, when it should not take a "set," but on being released resume its original form.

Cast steel is tested by making a "cold" chisel and trying its edge on iron or steel.

Metal. The principal alloys made use of in the Department, technically known as "metal," are as follows:—

Metal	Proportion	Use
Copper	86·80	For pipe boxes of wheels, and sheaves of blocks.
Tin	12·40	
Zinc	·80	
Copper	86·49	For rollers.
Tin	10·83	
Zinc	2·68	
Copper	84·22	For bearings and nuts of elevating screws, &c.
Tin	7·92	
Zinc	5·24	
Lead	2·62	

The first mentioned is harder than the second on account of the larger proportion of tin in it, and the second than the third.

The usual method of mixing the alloy is to melt all the tin, zinc, and lead with a small proportion of copper, and cast this into small ingots, forming in fact "white metal." These ingots are broken up and melted, when the remainder of the copper to form the correct proportion is added.

CHAPTER III.—LEATHER, ROPE, &c.

Leather.

The leather used in the Royal Carriage Department is that tanned by oak bark and not by a chemical preparation, which point is tested by cutting a small piece and moistening the edge, when a black mark down the centre of the edge will denote chemical preparation, while a brown colour shows oak tanning.

Well tanned leather should not crack when doubled up.

Leather requires to be periodically dubbed, being first well cleaned, namely, if in use, once every three months, and if in store, once in two years.

Dubbing is composed of train oil, 1 quart, neat's foot oil, 4 quarts, olive oil, 2 quarts, and tallow, 13 lbs.

The chief descriptions of leather are, "hides," *i.e.*, prepared from ox or cow hides, strapback for strapping, cloak case for thongs, bellows for bellows of forges (these are dressed in oil), and mill band backs for bands of machinery. Also "basils," *i.e.*, prepared from sheep skins, strained, for the inside strapping of boxes.

Rope.

A rope is formed of three strands, each strand consisting of a number of yarns, and each yarn of a number of fibres of hemp.

Rope is either tarred or white,* and of each there are different sizes according to the number of yarns in the rope; the size is expressed by the length of the circumference in inches.

The strength of rope when new, that is, the weight in tons which it will bear, is approximately given by squaring the circumference and dividing by six.

Rope is issued in coils of 113 fathoms each, marline and Hambro' line in skeins, and spun yarn in lbs.

Government rope is distinguished by a coloured thread, red, yellow, or blue, running through it.

The following are the principal sizes of rope and their chief uses :—

12-in. white, slings of sheers.
9 „ straps of sheers.
6 „ main tackle of sheers, guys, slings.
5 „ gyn falls.
4 „ gyn falls.
3 „ gun tackles, drag ropes.
2½ „ gun tackles, drag ropes.
4½-in. tarred, guys of derricks, slings.
4 „ parbuckle ropes, lashings.
3 „ straps, lashings.
2½ „ luff tackles, lashings.
2 „ lever ropes, lashings.

Rope is liable, particularly white, to deteriorate when kept long in store, and if the store is damp to suffer from mildew, which will be most apparent in the interstices between the strands. Rope showing this is unserviceable, as may readily be tested by giving one of the yarns a sharp pull or jerk, when it will break.

Paint.

Lead paint is now used for woodwork instead of zinc paint, as giving a better "body" than the latter; it does not, however, go so far, that is to say, it takes 16 lbs. of lead paint to paint an equal surface to that which 9 lbs. of zinc paint will cover.

---

* Bolt rope is the best description of white rope.



For iron carriages Pulford's black is used, though sometimes, as in the case of iron field carriages, afterwards painted over with lead paint.

A carriage or other article when new receives three coats of paint, namely, priming, second, and finishing, all cracks and openings being stopped after the priming coat. One coat is not laid on until the previous one is dry, which takes at least 24 hours.

The following table gives the proportions in which to mix the ingredients for each coat :—

Ingredients.			Priming Coat.	Second Coat.	Finishing Coat.
Lead paint.	Lead colour.	Lead, white, ground	28 lbs.	56 lbs.	25 lbs.
		Black, lamp, ground	1 „	$2\frac{1}{4}$ „	$1\frac{1}{4}$ „
		Driers, patent	2 „	$3\frac{3}{4}$ „	$2\frac{1}{4}$ „
		Oil, linseed, raw	$10\frac{1}{2}$ pints	$11\frac{3}{4}$ pints	$8\frac{1}{2}$ pints
		Turpentine	—	6 „	—
	White	Lead, white, ground	28 lbs.	56 lbs.	28 lbs.
		Driers, patent	2 „	$3\frac{3}{4}$ „	$2\frac{1}{4}$ „
		Oil, linseed, raw	$9\frac{1}{4}$ pints	$9\frac{3}{4}$ pints	$7\frac{1}{2}$ pints
		Turpentine	—	5 „	—
	Grey (for Moncrieff carriages).	Lead, white, ground	56 lbs.	56 lbs.	—
		Lamp black	$\frac{1}{2}$ „	$\frac{1}{2}$ „	—
		Red Venetian	$\frac{1}{4}$ „	$\frac{1}{4}$ „	—
		Driers, patent	$4\frac{1}{2}$ „	$4\frac{1}{2}$ „	—
		Oil, linseed	15 pints	15 pints	—
Pulford's black		Black, Pulford's ground	112 lbs.	112 lbs.	—
		Litharge, ground	9 „	9 „	—
		Oil, linseed, boiled	31 pints	31 pints	—
		Turpentine	8 „	8 „	—

Before mixing pigments are well ground, then placed in a vessel, and one-third of the oil poured upon them, when the whole is well stirred until all lumps are dissolved. The remainder of the oil is next added, the stirring being continued until the oil has disappeared, after which the paint is strained through a fine strainer.

All paint requires to be stirred frequently while being used.

Ironwork requires to be cleaned before being painted, if rusty by a scraper or file, and if oily by washing with turpentine.

Knotting. Knotting is a patent varnish used for laying over knots previous to painting and for staining the wood of iron-pointed levers, &c. ; it should be laid on quickly.

Hard stopping. Hard stopping for shakes in woodwork is made by mixing dry white lead or white zinc, according as the woodwork is painted with lead or zinc paint, with gold size in the proportion of 1 lb. of the former to 1 gill of the latter.

Putty. Putty for stopping cracks in woodwork is made by mixing common whitening (putty powder) with raw linseed oil in the proportion of 1 cwt. of the powder to $2\frac{1}{2}$ gallons of oil.

Varnish. Varnish made of equal parts of boiled oil and copal varnish is used for varnishing the heads of side arms for rifled ordnance, &c.

Composition for bright iron-work.

Composition of tallow and white zinc in the proportion of 3 lbs. of the former to 1 lb. of the latter is used for coating bright ironwork to protect it from rust when kept in store.

Abel's waterproofing composition.

Abel's patent waterproofing composition for canvass is supplied in cakes; these are broken and melted with an equal quantity of mineral tar and a little lamp black (2 or 3 ozs. to 1 lb. of composition). The composition is laid on the canvass with a hard brush and then worked in with a hot iron.

Ordinary waterproofing composition.

Ordinary black waterproofing composition for canvass consists of lampblack 24 lbs., litharge 13 ozs., boiled linseed oil 74½ lbs., beeswax 11 ozs.

Clarkson's material.

Clarkson's material is used for making cartridge cases for M.L.R. heavy guns; it consists of canvass on the inner side, a layer of cork glued over it, by indian-rubber cement, and then in the same manner the cork covered with canvass, and this again with leather. The indian-rubber cement is made by dissolving india-rubber in naphtha in the proportion of 1 lb. of the former to 1 gallon of the latter; two coats are laid on between the surfaces to be cemented.

PART I.—FIELD CARRIAGES.

SECTION I.—WHEELS AND AXLETREES.

CHAPTER I.—PRINCIPLES OF CONSTRUCTION OF WHEELS.

Before saying anything about the construction of a wheel it may be well to define what the "object" or "mechanical advantage" of a wheel is, and also to state what is meant by "resistance to rolling."

The object of a wheel.

With regard to the object of a wheel: suppose a carriage had not wheels, and in that condition was dragged over the ground, in sliding over the surface much friction would be developed, resisting the motion. Let the carriage be placed upon wheels, and instead of the development of friction between the ground and the carriage, there will be friction of the axletrees upon the pipe boxes, but very different to what it was before. For in the first case it was between surfaces over one of which there can be little or no control, namely, the ground, while in the second case it is between surfaces which can be varied and made such, as to material, that the friction may be a minimum and be still more reduced by the employment of grease. Further, the friction acts with less power at the axletree, in the proportion of the radius of the axletree to that of the wheel. We learn therefore that the primary object of a wheel is to remove the sliding friction, which would otherwise take place between the carriage and the ground, to the axletree arms, where it is under control, and where it presents a minimum resistance to motion. The wheel also attains another object, namely, in giving an advantage in overcoming small obstacles, by affording the power, dragging the carriage along, a leverage, H, B, *Fig.* 1, at which to act with regard to the resistance of the weight of the carriage and load due to the obstacle, and which acts with a leverage B, C.

Fig. 1.

Resistance to rolling.

With regard to resistance to rolling it is due partly to the imperfections of the road, that is to say, to the unevenness of the surface, or softness and want of elasticity, and partly to irregularity of form in the

wheel itself. The want of perfect evenness presents obstacles at each instant, to the height of which, in order that the wheels may surmount them, the load has to be raised. While the want of perfect hardness causes the ground to yield, so that the wheels in their onward progress are continually opposed by the materials of the road immediately in their front. In the case of a perfectly elastic road this would not be, for though the road would yield under the weight, it would expand of itself again just as much as compressed, and in so doing would react upon the wheels.

Construction of a wheel.

Wheels are divided into classes, and the scantling of the material for each particular part of a wheel, in each class, has been determined from the results of experience.

The wood nave.

The nave or central part of a wheel is made in some cases of wood and in others of metal; for the stock of a wood nave elm is used on account of its cross grain, and little liability to split, as well as on account of its lightness: oak is used as a substitute for elm occasionally. The fibre is placed in the best direction to resist the principal thrust of the feet of the spokes which enter it, namely, running from end to end or perpendicular to the plane of the wheel, and the wood is strengthened in its weakest direction, namely, radially by wrought-iron hoops.

The stock must be of sufficient diameter to yield the required support to the feet of the spokes: its length is governed by the strength required in it to resist the thrust in that direction of the feet of the spokes, and also by the length considered necessary for the pipe box, or that part which immediately takes the bearing of the axletree, the length of which latter is ruled by other considerations mentioned further on.

With regard to the mortises for the feet of the spokes, they should be so placed in the length of the stock that, when the wheel is completed with the required amount of dish and on its carriage, the perpendicular from the centre of resistance or centre of the bearing part of the tire, upon the ground, should pass within the cross section of the lower or working spoke through the centre of pressure, in order that there may not be any cross action of the pipe box upon the axletree arm. The centre of pressure in practice is frequently taken as represented by the central point of the axis of the pipe box, though in reality it lies inside of this point.

The diameter of the pipe box must correspond to that considered necessary for the axletree arm upon which it has to work, only sufficient play to admit of freedom in working being allowed between them, so that, should there be any cross action of the pipe box upon the arm, it may have as little room for action as possible.

The length of the pipe box must be sufficient for the proper stability of the wheel upon its arm, also to furnish, besides enough grease recess, sufficient frictional bearing for the arm to prevent too rapid wear. Again, it cannot be shorter than the least length considered necessary for the stock.

The metal of the pipe box should be such that it will not produce much friction with the metal of the arm, nor wear from what friction may be produced: further, the metal ought not to be liable to be scored from grit. The axletree arm being of wrought iron, a "metal" pipe box has the advantage of a chilled cast-iron box as regards friction, but being softer than the latter, stands at a disadvantage in point of wear and suffering from grit.

The metal nave.

The general principles of construction given for a wooden nave hold good equally in the case of a metal nave: it is further necessary in the latter that the metal of the flanges be such that it will not crack from

jolting, or fly if struck by a shot. In this view the flanges are made either of "metal" or of wrought iron; the latter for wheels of transport carriages, as being both lighter and stronger than the former, which has been adhered to, as first adopted, for all artillery carriages.

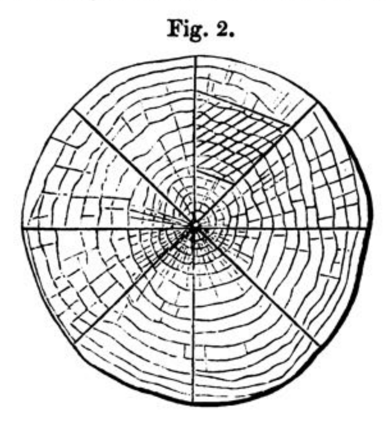
The metal of the flanges is so disposed as to yield the greatest strength where the greatest pressure may fall, and in the case of wrought-iron flanges the fibre is made to run radially as being the best direction.

In a wooden nave the feet of the spokes never rest upon the pipe box, from the mode of manufacture more or less vacant space being left between them and the box; consequently when the stock shrinks and the mortises enlarge, the spokes have opportunity of entering further into the latter. When this is the case, as the wheel revolves and each spoke in succession becomes the working spoke, it will be pressed into the stock as far as it can go, while the spokes which for the time are the upper will be rather drawn out from the stock. Thus, as the wheel continuously turns round the spokes will work in and out of the nave and the wheel cannot last. In the metal nave it will be seen that this evil does not exist, and that the feet of the spokes rest upon the pipe box. This nave has also the advantage over the wooden one in point of material as regards durability, but is at a disadvantage in point of weight and cost.

The spokes.

Spokes, from their position in the wheel, must be of comparatively small dimensions in cross section as compared to their length, yet the most severe stress they are subject to is in the former direction, from the lateral thrust brought to bear upon the nave when one wheel becomes lower than the other by dipping into a rut. Consequently spokes are made of such strong wood as English oak, or, wanting that, of African oak, with the fibre running in the direction of the length. Their number varies with the diameter of the wheel, 12 being fixed upon as the complement for the 5′ wheel. To ensure the proper direction of the fibre the tree is cleft radially, *Fig.* 2, to form the half-wrought spokes,

Fig. 2.



and therefore the latter show upon their sides what is termed the "felt," or that appearance of the fibre which is presented in a plane radial to the longitudinal axis of the tree.

In cross section a spoke is made deeper from back to face than from side to side, that in form it may be as much as possible adapted to resist the occasional lateral thrust mentioned, and the foot is made stronger than the body, as the greatest strain comes upon it. Further, in order to place the spokes in a better position (compare Figs. 1 & 2, Plate I.) to resist the lateral thrust the wheel is "dished" or formed into a kind of dome, strictly speaking, a hollow frustrum of a cone, and just as the

dome or arch is strong from its form to resist pressure upon the crown tending to crush it in, so is the wheel made strong by the dish to resist the lateral thrust tending to force the nave outwards. In fact, not only do the spokes, sustained by the tire, yield mutual support to each other, but the lateral thrust upon each individually becomes converted into a compressing strain, which the wood has better power to resist.

The greater the dish the stronger will the wheel be to resist the lateral thrust, but for certain reasons to be hereafter mentioned no more dish should be given to a wheel than absolutely necessary for the safety of the spokes.

The amount of dish in a wheel is measured along its axis from the point A, Fig. 3, Plate I., where the prolongation of the face of the spoke meets that axis, to the point B, where the perpendicular let fall from the extremity of the face at the bosom of the felloe meets the same axis. This in the older field wheel of 5′ diameter is $2\frac{1}{2}''$, and hence is said to be $\frac{1}{2}''$ to the 1′, but incorrectly, because, as stated, the dish is not measured with reference to the radius, much less the diameter of the wheel, but to the distance from the axis to the bosom of the felloe. In the later field wheel with metal nave the dish has been reduced to 2″, and experiment has shown that it cannot be further reduced with safety to the spokes, except in some cases where the dish of a low front wheel is made to suit the track of the hind wheel.

The amount of dish in wheels not of 5′ diameter is proportional to that in the 5′ wheel, that is, to $2\frac{1}{2}''$ if O. P. and 2″ if N. P. for the relative lengths from the axis to the bosom of the felloe. This results in all O. P. wheels having the spokes set at the same angle to the axis, and in all N. P. wheels having theirs at the same angle, but a different angle to that in the O. P.

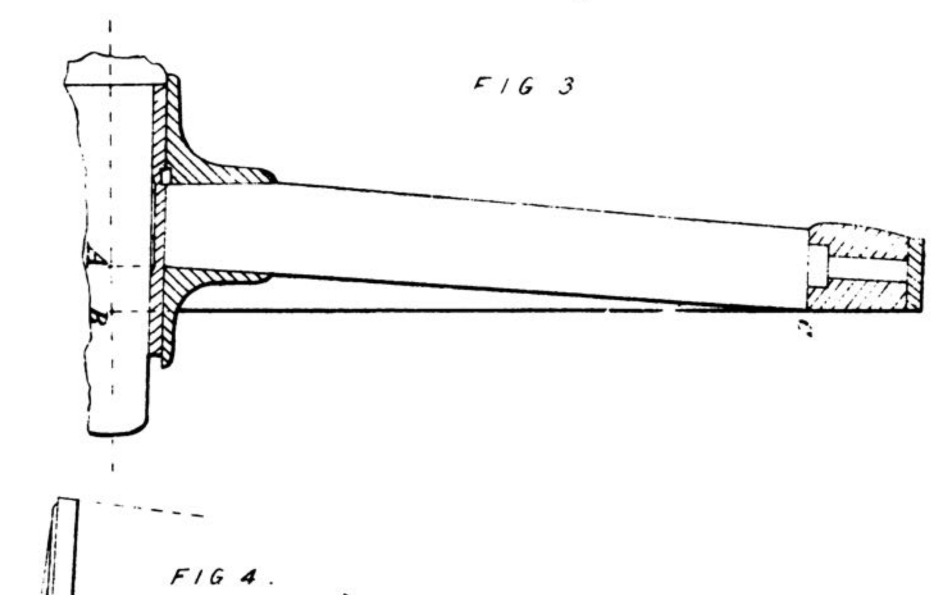
Dishing a wheel carries with it some minor advantages, for instance, giving greater width between the wheels above the axletree for the load, but one grand disadvantage, namely, the bevelling of the periphery or sole of the wheel, which is brought about by the necessity consequent upon the dish, as will be hereafter explained, of having to set the axletree arm at an inclination downwards. The bevelling is an evil, because it makes the wheel conical in form, Fig. 4, Plate I., instead of cylindrical, which it ought to be. Now a cone, if put in motion on the level, will not roll in the same manner as a cylinder, straight forward, but will describe a circle round its apex O, as centre; so the wheel, if set in motion and free, would describe a circular path round the point where the prolongation of its periphery would meet the prolongation of its axis, or in other words where the latter would meet the ground. On the carriage the wheel cannot pursue such a course, but is compelled to move in a path unnatural to it, in fact, the path of a cylinder. Consequently the wheel, instead of simply rolling, partly slides, thereby tending to defeat the primary object of the wheel, the evil increasing in importance in proportion to the width of the tire.

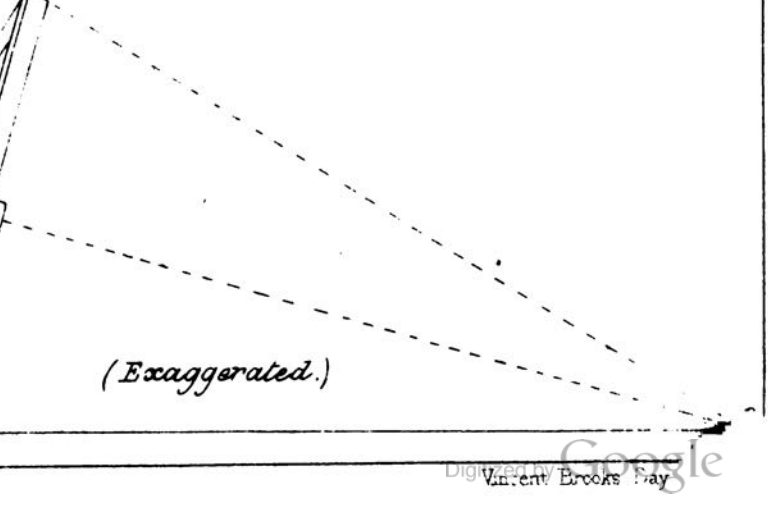
The dish of a wheel is tested practically by laying a straight edge across the wheel just above the nave, and measuring the perpendicular distance from it to the foot of the spoke: the distance measured should agree with the same distance calculated by similar triangles, or with the same distance measured on a wheel of the same nature, whose dish is known to be correct.

The felloes. Ash, as a strong and elastic wood, is used for felloes. The number of felloes in a wheel varies with its diameter, and is fixed by the considerations that the length of each must not be so great as to necessitate the fibre of the wood being much cut across in shaping the felloe, and at

FIG 1.

FIG 2.





Vincent Brooks Day

the same time, the fewer felloes there are the better for the strength of the wheel, the junction between every two being a weak point. In the 5′ wheel six felloes is the approved number, each receiving two spokes at points equidistant from its centre and ends, that the pressure from the spokes may be as fairly distributed as possible. In other wheels the same rule is generally followed, that there should be one felloe to every two spokes, but some transport wheels have been made with a felloe to every spoke, which has the advantage of using up short pieces of ash, which are usually the more sound.

Felloes are cut to a larger radius than the wheel for which they are intended, in order to allow for the drooping to which their ends are liable, and from this circumstance a new wheel does not form a perfect circle, but is of slightly greater diameter over the junctions between the felloes than elsewhere. Consequent upon the felloes being cut in this manner, their ends slope away slightly towards the sole, and this makes the joinings very close at the bosom.

The bevel of the sole of the felloes is dependent upon the amount of downward inclination given to the axletree arms, and must be such that when the wheel is completed and upon its carriage, the tire shall bear fairly upon the ground.

The faces of the felloes lie in the same plane perpendicular to the axis of the wheel, being so made for convenience of manufacture.

The tire.

The tire, made of wrought iron on account of its strength and toughness, has the fibre running circumferentially so as best to resist the radial thrust communicated through the spokes. The width of the tire to some extent depends upon the scantling of the felloes, but mainly is governed by the considerations that it ought to be at a maximum for passing over yielding ground, and at a minimum for lightness; with regard to the latter point the thickness of the tire should also be at a minimum consistent with strength.

Comparing a tire made in one complete ring with one made in parts or "streaks," we see that the former gives much better support to the other parts of the wheel, but in the case of a wooden nave, should the latter shrink, it cannot follow up the movement of the spokes mentioned before, which the streak tire (there being a small space between the ends of the streaks and the bolts holding it being capable of yielding a little) to a certain extent can, and thus prevent the play of the spokes. The streak tire also admits of readier repair should a felloe be damaged, but on the other hand, by reason of the number of bolts and rivets which it entails through the felloe, weakens the latter more than the ring tire, which requires but one bolt, or at most two, through each felloe.

Height of a wheel.

The height of a wheel equals its greatest diameter, which is that of the back. The considerations which govern it are the following:— the greater the diameter the better for overcoming the resistances presented by the ground and for passing over a yielding surface, in the first instance by giving what may be termed greater leverage, in the latter by affording a larger arc of contact. At the same time increase of diameter carries with it increase of weight, cost, decrease in the stability of the load, and in the case of a gun carriage wheel, inertia to recoil. There are however cases in which inertia to recoil is a desideratum, as in the M.L.R. field gun carriages, on account of the comparative lightness of the guns, their large charge, &c., providing the strength of the wheels admits of their accepting it. Besides having regard to the foregoing points, the height of a wheel must also be ruled by convenience of height for the load and of the shafts for draught. In the field wheel the height of 5 feet has been adopted as best fulfilling the



above conditions, and in the transport wheel the height of 4′ 8″; in other wheels the height is varied to suit special circumstances.

Weight of a wheel.

With regard to the weight of a wheel, it should be at a minimum for mobility, and if for a gun carriage inertia of recoil, consistent with strength, but as before said, there are cases in which it is advantageous to increase the inertia. It is further convenient, when circumstances admit of it to have the weight not too great for two men to lift.

CHAPTER II.—CLASSIFICATION AND CONSTRUCTION OF WHEELS.

Parts of a wheel.

As already detailed in the preceding chapter, the principal parts of a wheel are, the nave, the spokes, the felloes, and the tire; and the pipe box is that part of the nave which takes the bearing of the axletree.

Classes of wheels.

The classes into which wheels are divided are, first, second, third, and special, according to the size or internal dimensions of their pipe box; this in the first class is larger than in the second, and in the second than in the third, the scantling of the parts of the wheel following the same rule.

In the first, second, and third classes every wheel in the class has the same sized pipe box, though in weight and diameter one wheel may differ from another.

The special class, however, consists of wheels whose pipe boxes differ in dimensions one from another as well as from those of wheels of the other classes.

Patterns of wheels.

There are two distinct patterns of wheels in the service, namely, the older, with a wood nave, and the more modern, which is known as the Madras pattern, with a metal nave.

Wheels though of the same class and same diameter are not interchangeable if of different pattern.

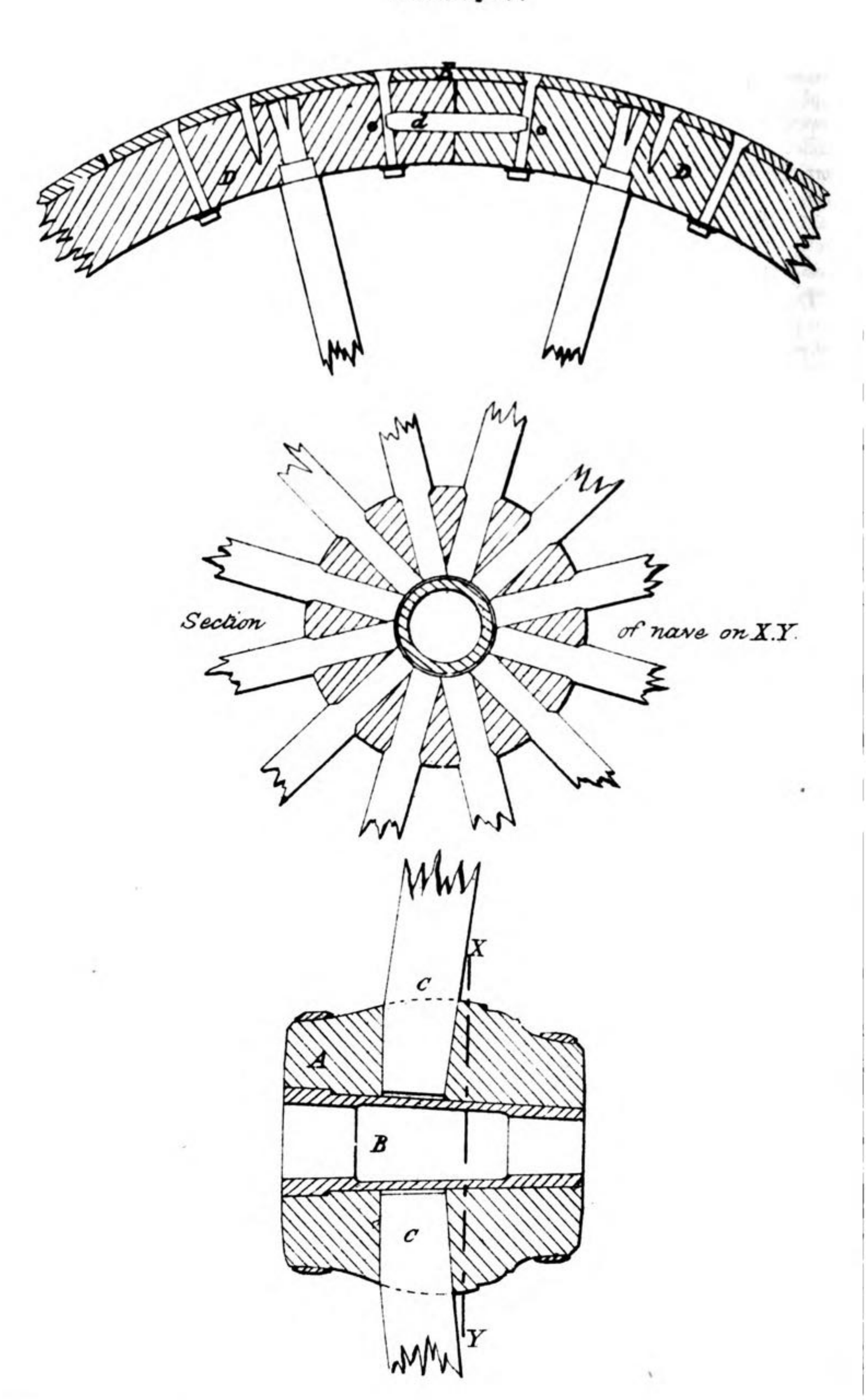
Table of O.P. wheels.

The following table gives the principal O.P. wheels still remaining more or less in use for field service.

Class.	Nature.	Weight.			Diameter.		Width of Tire.
		cwts.	qrs.	lbs.	ft.	in.	ins.
I.	Siege - - - - - -	4	2	0	5	0	6
II.	Carriage, 10″ and 8″ mortar - - Cart, trench - - - - Wagon, siege - - - -	1	2	26	4	2	3
	Field, heavy - - - - -	2	1	12	5	0	3
	,, light - - - - -	2	0	7	5	0	3
	Wagon, platform, fore - - -	2	0	9	4	0	4
	,, ,, hind - - -	3	0	0	5	0	4
III.	Cart, hand - - - - Carriage, 6 pr. B.L.R. - - - Wagon, general service (equirotal) -	1	1	0	4	2	3
	Cart, forage - - - - Carriage, 6 pr. B.L.R., special - -	1	2	5	5	0	3
Special	Barrow, ammunition and store, China pattern - - - -	0	1	18	3	0	$1\frac{3}{4}$

The following description of the light field wheel will illustrate the construction of all wheels made with wood naves.




Scale 1½" = 1'.
d
D
D
Section of nave on X.Y.
X
C
A
B
C
Y

The nave consists of a stock of elm A, containing a cast-iron pipe box B, concentric with its longer axis. The stock is cut transversely and has a hoop of wrought iron shrunk over each end and secured by three stubs. Mortises for the spokes are cut in the stock at an angle to its axis in order to give the spokes a certain inclination outwards, termed the "dish," in this instance amounting to $2\frac{1}{2}$ inches. The pipe box is conical in shape, 13 inches long; its interior is enlarged towards the middle to form a grease chamber, and its bearing parts are chilled to render them sufficiently hard. The box is prevented from turning independently of the stock by two feathers cast upon its exterior at the larger end, and is secured by oak wedges driven into each end of the stock round it. When in position the pipe box should be truly concentric with the ring of the wheel, and the wedges afford the means of bringing it so.

Construction of the light field wheel O.P. (Plate II.)

The spokes C, twelve in number, are of oak, as already mentioned: that part of the spoke which enters the nave is termed the "foot," that which enters the felloe the "tongue." The outer edge or "face" of the spoke is straight, the inner or "back" is not; the tongue is set at an angle to the face in order that it may pass through the centre of the felloe, and is split to take an oak wedge which is driven into it when the felloe is placed, in order to keep the latter tight down upon the shoulder until the tire is on.

The felloes D, six in number, of ash, are cut with the grain and bevelled off on the convex side: they are struck out with a greater radius than that of the wheel in the proportion of 1′ $0\frac{1}{4}$″ to 1′ 0″ and are connected by oak dowels, *d*. The convex surface of a felloe is termed the "sole," the concave the "bosom," the outer side the "face," and the inner the "back." Wheels shod with a streak tire have a rivet through each end of every felloe to prevent the latter splitting, from the number of bolt holes which that kind of tire necessitates in it.

The tire E is of wrought iron $\frac{5}{8}$″ thick; until 1868 it was made in six pieces or "streaks": in that year the "streak" was superseded by the "ring" tire, which is simply a hoop of varying diameter to suit the bevel of the felloes, shrunk on and secured by a bolt through the centre of each of the latter; a burr is placed under the nut of each tire bolt.

The date of manufacture is stamped on the nave, also the letters Lt. (light), and the wheel receives three coats of lead color paint.

The heavy field wheel differs from the light in being of slightly stronger make; namely the felloes $\frac{1}{4}$″ deeper, the nave greater in diameter by 1″, and the feet of the spokes larger.

The following table gives the Madras pattern wheels.

Table of Madras pattern wheels.

Class.	Nature.	Weight. cwts.	qrs.	lbs.	Diameter. ft.	in.	Width of Tire. ins.
I.	Sling wagon, iron, to 7 tons	6	3	12	7	0	6
	Siege	4	3	0	5	0	6
II.	Cart, S. A. ammunition	1	2	4	5	0	$2\frac{1}{2}$
	Cart, spring, iron frame (Perkyn's)	2	1	9	5	0	$2\frac{1}{2}$
	Field, heavy	2	0	26	5	0	3
	" light	2	0	6	5	0	$2\frac{1}{2}$
	Wagon, R.A., fore	1	2	4	3	4	$2\frac{1}{2}$
	" G. S., iron frame, spring, heavy; Wagon, bakery; Wagon, bread and meat } fore	1	2	3	3	6	$2\frac{1}{2}$

Class.	Nature.	Weight.			Diameter.		Width of Tire.
		cwts.	qrs.	lbs.	ft.	in.	ins.
II.	Wagon, G. S., iron frame, spring, heavy - - (hind); Wagon, bakery - - (hind); Wagon, bread and meat - (hind); Cart, tip, iron frame - - -; Cart, spring, iron frame - -	1	3	26	5	0	2½
III.	Carriage, Gatling - - -	1	1	7	4	8	2
	Cart, spring, iron frame - -	1	2	8	4	8	2¼
	Wagon, G. S., iron frame, spring, light - - - - (fore); Wagon, ambulance, II. - - (fore)	0	3	13	3	0	2
	Wagon, G. S., iron frame, spring, light, hind - - - - - -	1	0	21	4	6	2
	Wagon, ambulance, II., hind - -	1	1	0	4	8	2
	Wagon, G. S., II., fore - -	1	0	9	3	4	2½
	" hind - -	1	2	22	4	8	2½
	Wagons, R.E., fore * - - -	1	0	21	3	6	3
	Wagons, R.E., hind * - - -; Carts, R.E. - - - -	1	2	10	5	0	3
Special.	Carriage, 7-pr. bronze of 224 lbs., or steel of 200 lbs. - - -	0	2	12	3	0	2
	Carriage, 7-pr. steel of 150 lbs., or bronze of 200 lbs. - - - -	0	2	7	2	6	2

* The now proposed wheels for R.E. wagons are, fore 3′ 4″, hind 4′ 8″, weighing respectively 131 and 172 lbs.

Construction of the light field wheel, Madras pattern. (Plate III.)

The following description of the light field wheel, Madras pattern, will illustrate the construction of all wheels of that pattern:—

The nave is of metal made in three principal parts; namely, the pipe box A, the inner flange B, and the outer flange C.

The pipe box internally is conical in shape and enlarged towards the middle to form a grease chamber: externally its surface is that of two conical frustra of different slope, standing base to base, one base being of slightly larger diameter than the other so as to form a shoulder for the inner flange to bear against. A wrought-iron feather is let into the end of the pipe box on which the inner flange fits, a slot being cut in the latter to receive it, which ensures the pipe box revolving with the flange and remainder of the wheel. In length the pipe box is 10″ or 3″ shorter than the light field wheel, with wood nave. The flanges are of softer metal than the pipe box. The surface of the outer flange against which the spokes bear is so formed as to give the required amount of dish to the wheel, namely, 2″ or ½″ less than in the O. P. field wheel. The flanges when in position upon the pipe box project a little beyond each end of the latter, thus giving protection against grit getting in, as the shoulder of the axletree and the washer enter the recesses so formed. The outer flange is secured to the inner by a wrought-iron bolt D, triangular in cross section, between each pair of spokes: the bolt holes in the outer flange are triangular and in the inner circular, and the bolts are nutted upon the inside. Over each bolt, to exclude moisture, a bit of oak is fitted and held by nails to the adjacent spokes.

The spokes E, differ from those of the wood naved light field wheel, principally in the shape of the feet, which are cut so as to form a perfect arch round and resting upon the pipe box, completely filling the space between the latter and the bolts.

Scale $1\frac{1}{2}'' = 1'$.

Section of nave on X.Y.

The felloes are the same as in the O. P. wheel, except that they are turned off on the back at the sole to suit the narrower width of tire adopted for this wheel.

The wheel is shod with a ring tire $\frac{5}{8}''$ thick. The date of manufacture is stamped upon the back of one of the felloes.

Remarks upon other wheels of the Madras pattern.

The N. P. heavy field wheel differs from the light in having a tire 3″ instead of $2\frac{1}{2}''$ wide, and consequently in it the backs of the felloes are not rounded off: the felloes are also $\frac{1}{4}''$ deeper than in the last-mentioned wheel.

The flanges of all wheels for artillery service are of metal, those for the engineer and transport services of wrought iron: in the first class wheels for the more recent artillery carriages the flanges have not been made to project beyond the ends of the pipe box.

In the third class wheels for transport * and engineer carriages the interior of the pipe box is enlarged on the inner side (see Plate V.) to correspond to the shape of the axletree adopted for these carriages.

The wheels of the G. S. wagon, Mark II., constructed up to the present date have wood naves and strictly should have been placed in the first table with O. P. wheels: as however they have metal pipe boxes and belong to the latest pattern wagon it is more convenient to place them with the N. P. wheels.

Several of the third class 4′ 8″ wheels for transport spring carts have been made with as many felloes as spokes.

The pipe boxes of Madras pattern wheels are now made of harder alloy than at first, and such pipe boxes are distinguished by the letter "H" stamped upon the smaller end.

The wheel of the S. A. ammunition cart is peculiar in having spokes and felloes of the third class scantling.

Perkyn's wheel.

The wheel on some of the transport spring carts is Perkyn's patent: it has a cast-iron nave, bouched with case-hardened wrought iron, the latter representing the pipe box. The spokes are of wrought iron screwed into the nave and riveted at the tire, which is of wrought iron trough shaped. The joints of the felloes do not lie in the radius of the wheel but make an angle with it; they are tightly closed by a nut, working upon a thread cut on each spoke.

CHAPTER II.—EXAMINATION AND REPAIR OF WHEELS.

Examination of wheels.

Wheels should not be allowed to stand in the same position too long, particularly if the place is wet, and should be frequently examined.

Swelling of the wood is a sure indication of decay: if suspected, decay may be tested for by striking the part with a hammer, when a dull "thud"-like sound confirms the suspicion: a pricker should then be forced in and a portion of the fibre wrenched out and examined.

---

* Many of the pipe boxes of these wheels have a spiral groove for the better distribution of the grease.

As the paint preserves the surface it is necessary in testing to drive the pricker through the hard surface and ensure reaching any unsound part beneath.

Repair of a wooden nave.

In wheels with a wooden nave that part of the stock immediately behind the mortise holes is most likely to decay. Small faults may be cut out and a piece of wood let in. Small cracks or openings in the wood, provided they are in the direction of the axis of the nave, are not detrimental and may be filled in with hard stopping or putty; but cracks across the nave between the spokes show weakness, and, if extensive, condemn the wheel. The nave hoops frequently become loose from shrinkage of the stock, in which case they should be removed, a piece cut out, the hoops re-welded, and shrunk on again.

The pipe box should be examined to see that it has not become too much enlarged; it sometimes becomes loose in the stock from heavy work, or from heating, and then requires to be re-wedged in; if from the latter cause, the hole in the stock may be enlarged, and grease have penetrated between the box and the wood. In this case, before re-wedging, the pipe box must be removed, freed from all grease, and packed round with a piece of painted canvass. In re-wedging, care must be taken to get the box truly concentric with the ring of the wheel; this is done as follows:—the pipe box being placed in the stock, the wedges at the back are first driven in and their ends sawn off, the wedges at the face being then placed in the holes for them, the wheel is put upon its axletree arm and raised clear of the ground by a jack under the axletree; a block is next laid upon the ground, almost touching the face of the lower felloe, a piece of chalk held upon it as close as possible to the felloe without touching it, and the wheel turned round upon its arm. If then the pipe box is not truly concentric, the chalk will touch the felloes in places. The wedges are then driven, those nearest to the chalk marks first, and the wheel again tested. If further chalk marks appear, the wedges on the same side as the marks are knocked in a little more, and so on until the box is brought truly concentric, when the ends of the wedges are sawn off.

A wheel with a wooden nave, when returned for examination and repair, should always be tested for concentricity of the pipe box.

Repair of metal nave.

Should any part of a metal nave be damaged seriously it can be replaced. The metal pipe box is liable to score from grit getting in between it and the axletree; should this occur in travelling, it will make itself apparent by a grinding noise and by heating of the nave. The wheel should then be removed, and both the pipe box and axletree arm thoroughly cleaned, any burrs filed down carefully, so as not to increase the play between the box and the arm, fresh grease put on, and the wheel replaced. The play allowed between the box and the arm in manufacture for artillery carriages is ·017″, and for transport ·032″ in the diameter.

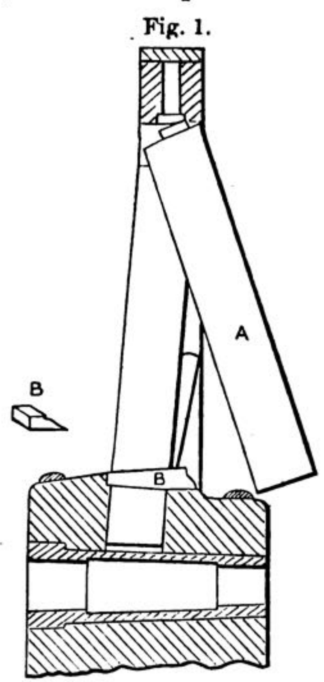
Repair of spokes in a wheel with a wooden nave.

Spokes are not very liable to decay, but in a wheel with a wooden nave they may become loose either from heavy work or from shrinkage of the stock. This is remedied by removing the tire or part only if a streak tire, and cutting very thin slices off the ends of the felloes, at one or more of the joints (running a saw through the joint is generally sufficient, taking care not to cut the dowel pins), then replacing the tire, previously shortened.

A broken spoke may be temporarily replaced in a wheel with a wooden nave, as follows; the spoke is sawn across close to the nave and to the felloe, a shallow slot cut with a chisel in the nave over the foot of the broken spoke, inclining upwards from the face of the nave, and about

1′ of the tongue removed from the felloe. A new spoke A, with a short tongue and the foot shaped to the incline of the slot, is then inserted in the felloe, and driven up the slot in the stock. When in

Fig. 1.



position, the new spoke is secured by a small piece of wood B, nailed in front of it in the slot.

If a ready-made spoke is not at hand and it is necessary to shape one, it is to be remembered that the face of the spoke is straight throughout, the correct angle of the extremity which meets the bosom of the felloe with the face is obtained by a "bevel" from one of the other spokes, and the tongue is cut at right angles to that extremity.

If several spokes have to be replaced in a wheel, the tire and felloes over them must be removed. When the new spokes are in position, their correct inclination in the nave is tested by means of a "face set," which is a straight edge laid upon the face of the nave and pivoted in its axis, a pin projects from its extremity over the ends of the spokes near the felloes, so that as the edge moves round, it shows whether the extremities of the spokes are equidistant from the straight edge or otherwise. Of course when equidistant, all the spokes stand at the same inclination.

Repair of spokes in a Madras-pattern wheel.

To replace temporarily a damaged spoke in a wheel with a metal nave, the inner flange and pipe box are removed, and the damaged spoke, if not already broken, cut across near the foot. The upper part is then removed from the felloe either by knocking it out or by cutting it off and making a fresh hole about 1″ deep for the tongue of the new spoke. Half of the foot at the back is next split off with a chisel, so making a partial space for the foot of the new spoke, yet leaving a piece of the old to retain the feet of the other spokes in position. The new spoke with a short tongue is then carefully driven in, the piece of the old spoke being knocked from beneath its foot when necessary. Finally, any part of the foot projecting inside the circle of the other feet is cut off, the foot is painted, and the parts of the nave replaced.

Repair of felloes.

The felloes are the most vulnerable part of a wheel; decay usually commences at the extremities immediately under the tire, from moisture

penetrating at the joints. In a wheel with a wood nave, the felloes by reason of the shrinkage of the wooden stock and the consequent inward movement of the spokes are liable to droop at the joints, causing openings at the bosom. This defect is remedied by removing the tire, or if a streak tire, so much only as necessary, and cutting small wedge-shaped pieces off the ends of the felloes, shortening the tire to correspond, and putting the wheel together again.

To put a new felloe in a wheel, the felloe is first shaped and cut to accurate length by the old felloe, then bored, the ends painted, and the dowels put in. The tire and old felloe being removed, the adjacent ends of the next felloes are knocked up a little to allow of the new felloe with with its dowels being placed. This being done, and the adjoining felloes at the same time knocked down again, the tire is re-shrunk on. In this operation it sometimes happens that the tongues of the spokes get broken, in which case the spokes must be renewed.

In a wheel shod with a ring tire as a temporary measure, a damaged felloe may be replaced without removing the tire as follows:—in a finished new felloe four rivet holes are bored from side to side, and the felloe sawn vertically down the centre. The old felloe being removed, the parts of the new are placed in position on the wheel, and burrs being placed under the ends of the rivets, riveted together.

Forming a ring tire.

To form a ring tire, a bar of wrought iron of the required width and thickness is taken, and the wheel to be shod run upon it to obtain the approximate length of tire, which length is then cut off. A workman of good judgment, before cutting it, would be able to make proper allowance for closing the openings of the joints of the felloes, for shrinkage, &c., and so avoid the necessity of having to cut the bar a second time to accurate length. After being cut, the bar is bent by chaining one end of it to a wheel with the tire on, and forcibly rolling the wheel along the bar. The circumference of the wheel to be shod is now correctly taken by means of a "traveller," which is a circular plate of iron about 6″ in diameter fixed on a spindle through the centre in a forked handle, and which is run along the centre of the sole. This length is then laid off on the inside of the tire bar along the centre, an addition being made, usually equal to the thickness of the bar, for loss in welding, and a deduction according to the openings of the joints of the felloes, sufficient to close those openings and pull the wheel well together. The openings of the felloes are measured along the centre of the face, and the amount the tire is made shorter than the circumference of the felloes should be double the total amount of the openings if those openings do not exceed ½″, but not quite double if they do. The ends of the tire are next scarfed down and welded together (for welding it is very convenient to rivet the ends roughly together), care being taken to make the tire if anything rather too short than too long, as if too short it is easily drawn out, but if too long it must be cut and rewelded. The tire is finally brought to suit the bevel of the felloes by hammering it cold along the inside on one edge, when the length is again tested and if necessary corrected as just mentioned.

A tire of greater width than 3″ has to be upset at each end before being bent, allowance for which must be made in the first measuring: the upsetting is rendered necessary to allow for the wasting of the iron in taking several heats.

Shortening a tire.

It is frequently necessary to shorten a tire on account of the shrinkage of the wood or on repair of the drooping of the felloes, if so, in the case of a ring tire, when it is removed and cut, the correct length is ascertained in the same manner as just described in making a ring tire. In the case of a streak tire, the proportion taken off the streaks should be to

FIG 1.
Scale. 1"=1'
(Hollow exaggerated.)

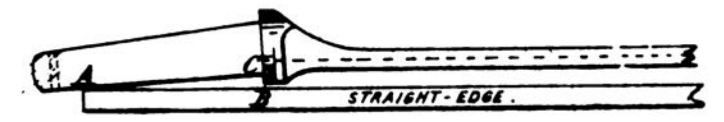


FIG 2.

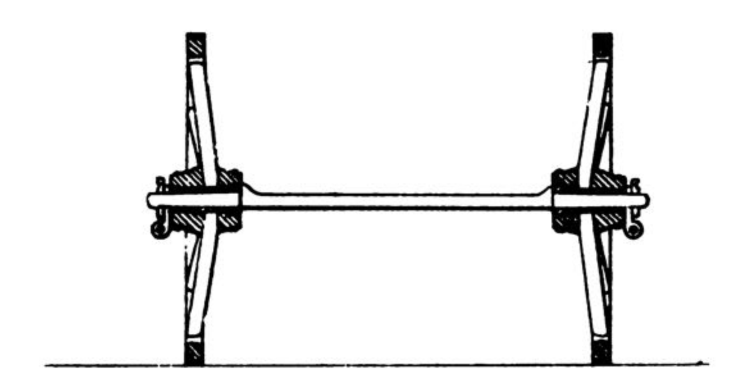
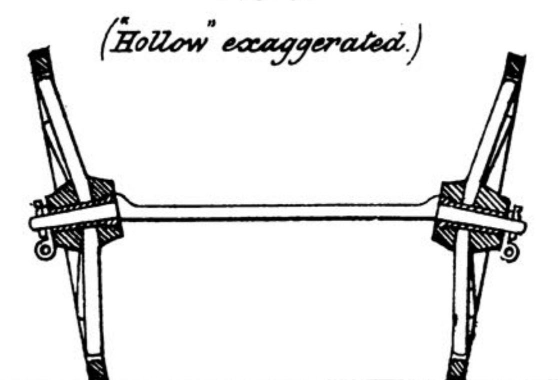


FIG 3.
("Hollow" exaggerated.)



the total openings of the felloes at least as 4 to 3. A streak is shortened by heating it in the centre and then upsetting the ends, so as to make the bolt holes still answer.

Shrinking on a tire.

To put on a ring tire in the field it is laid horizontally on three or four flat stones to keep it off the ground and heated with a wood fire. The wheel is similarly placed face down, and the tire when at a dull red heat dropped over it and shrunk by pouring water upon it. Shrinking the tire requires to be done carefully, and the wheel, particularly if one with a wooden nave, watched during the operation, in order that the shrinkage may be uniform, and every joint of the felloes properly closed. As the operation proceeds the pressing together may be assisted by blows with a mallet on the tire over the spokes. When the tire is cool the bolt holes are drilled, the bolts put in and tightly nutted : if the wheel has been shod before, previous to re-shoeing it the old bolt holes in the felloes (except one) should be plugged up.

A streak tire is shrunk on streak after streak similarly to a ring tire, but it is convenient to have the wheel upon an arm, and its lower felloe in a trench of water, so that the wheel can be turned round and each streak cooled in succession. Before the last streak is put on, the wheel is brought together by a "Sampson," to form bearings for which the nearest bolts of the two adjacent streaks are knocked up.

When wheels are in use the tire bolts should be looked to and kept tightly nutted.

Use of grease in repairs.

Grease must not be used to facilitate any operation in putting the parts of a wheel together, as it prevents firm union ; water may however be used.

Marking after repair.

Wheels repaired in the Royal Carriage Department have the letter "R" and date of repair stamped upon them.

Painting after repair.

After repair, the repaired parts are patched over with paint, and if the wheel requires it a coat is also given to it all over, any cracks, &c., being previously stopped with putty.

CHAPTER IV.—PRINCIPLES OF CONSTRUCTION OF AXLETREES.

Material.

Wrought iron is employed as the material for axletrees on account of its strength and toughness, the fibre being made to run in the direction of the length. If for use with wheels having chilled cast-iron pipe boxes as before explained, the arms are steeled, Fig. 3, Plate VI., to prevent too rapid wear.

Dimensions and form.

The general dimensions of an axletree depend upon the nature and weight of the load it has to support and the weight of the wheels considered necessary for the carriage. For simplicity, axletrees, in the same manner as wheels, are divided into classes.

The length of the arm, or part which enters the pipe box, is governed by the length of the pipe box of the wheel, and the length of the body by the track it is desired that the wheels should have.

In practice the "length of the arm" is always taken as the distance from the shoulder to the linch-pin hole on the upper side, as it is impossible to measure it upon the axis.

The diameter of the arm at each point of its length should be a minimum, consistent with strength, for the sake of lightness and also that the friction between the arm and the pipe box may have as small a leverage in its favour as possible. Hence, follows the conical form

usually given to the arm, the greatest diameter being at the shoulder where the greatest stress comes: this form is also advantageous in facilitating the putting a wheel on: the slope of the cone of the axletree arm varies with each class. The point of the arm is rounded off to render it less liable to catch against anything.

In axletrees to be embedded in wood the body is made rectangular in cross section, that there may be a better hold or union between the axletree and the wood. The section is made greatest at the shoulder, that is, between the arm and outer point of connexion of the body to the bed, as the axletree there receives least support from the bed, while towards the middle where it is firmly united to the bed and receives more support from it, the section is less. The difference in section is made by curving the upper surface that the under may be straight and when in the bed lie flush, or nearly so, with the under surface of the latter.

In spring carriages for transport service and in the later patterns of G. S. wagons without springs, wood beds have been dispensed with as inconvenient and superfluous. In these carriages the whole strain, whether vertical or horizontal, is applied close to the shoulder of the axletree and the body within these straining points is relieved; hence, a smaller section is admissible for the latter, and as it has no strain in any particular direction, as well as for convenience in manufacture, its form is generally circular.

The hollow of the arm.

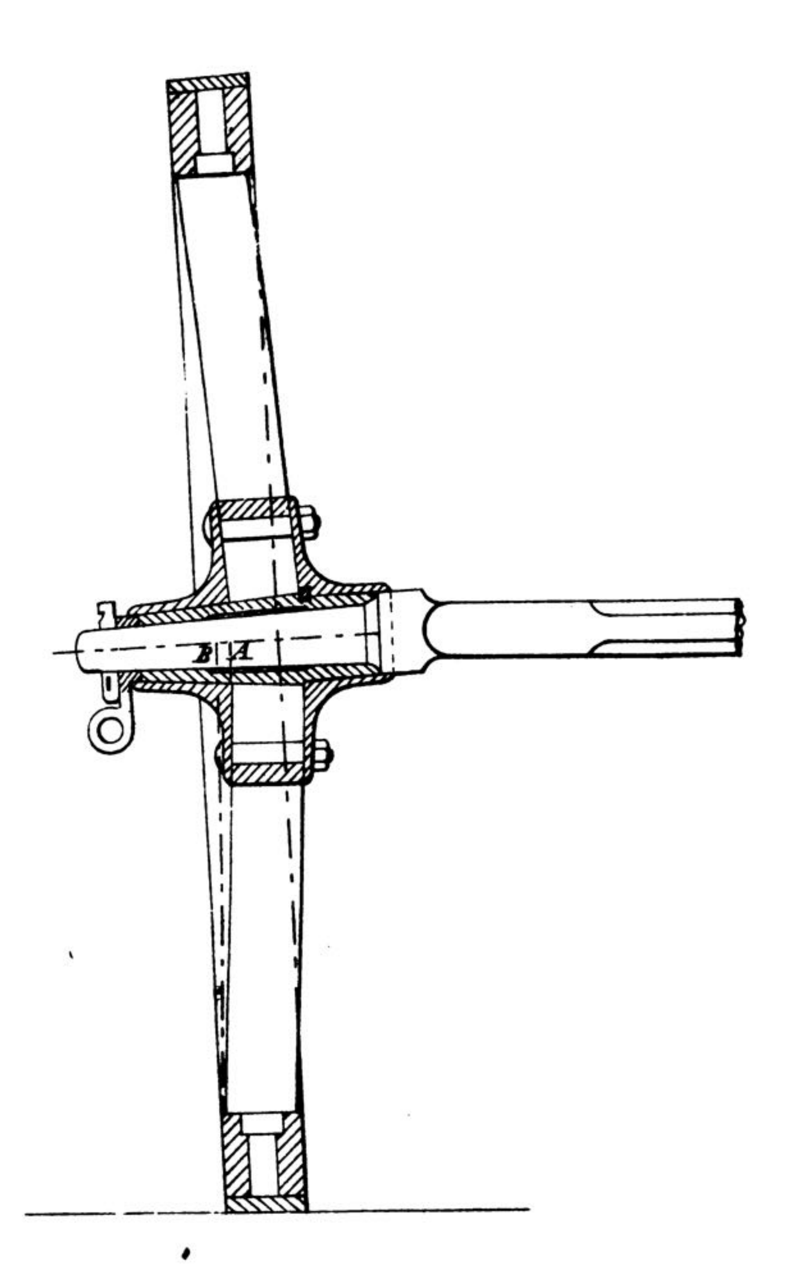
A downward inclination or "hollow" is given to the arm for the purpose of bringing the lower or working spoke vertical, Fig. 3, Plate IV., when it comes immediately under the arm, the wheels being on the level: otherwise, by reason of the dish of the wheel, the spoke would be in a bad position, Fig. 2, Plate IV.; in fact, the perpendicular to the ground from the centre of resistance would neither pass along the spoke nor through the centre of pressure in the pipe box. When, under the above conditions the working spoke is not brought quite vertical, but at an angle outwards to the vertical, the wheel is said to have a "strut." The amount of this is expressed in inches, measured along the axis of the wheel from the point A, Plate V., where the prolongation of the face of the spoke meets it, to the point B, where the vertical drawn from the extremity of the face of the spoke at the bosom of the felloe meets it.

Though on the level giving a strut to a wheel is slightly disadvantageous, on the whole a certain amount of strut is decidedly good, because it assists the wheel or rather its working spoke under the most trying circumstances, namely, when the wheel dips into a rut, &c. Formerly most wheels had more or less strut, for instance, the field wheel had about 1″: at present, the N. P. field wheel has no strut given to it, but the wheels for the transport carriages have, namely, ½″ in the 5′ wheel, and to others in proportion to their height.

It will be seen from the foregoing that the amount of hollow given to the axletree arm depends entirely upon the dish of the wheel together with the amount of strut which it may be thought desirable to give.

The hollow is expressed in parts of an inch and measured as the perpendicular distance from the point A, Fig. 1, Plate VI. in the under side of the arm distant from the shoulder the length of the pipe box to B, in a line drawn parallel to the axis of the body and tangent to the lower points of the basis of the arms. Practically, the hollow is measured by a gauge or by laying a straight edge parallel to the under side of the body, from a point A, Fig. 1, Plate IV., in the lower side of one arm distant from the shoulder the length of the pipe box to a similar point in the other arm, and then taking the perpendicular distance C, B, from

Scale $1\frac{1}{8}'' = 1'$.



Vincent Brooks Day & So

FIG 1

Scale 1"=1'

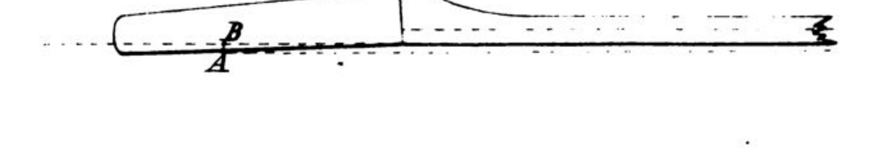


FIG 2.

Scale 1"=1'

("Lead" exaggerated.)

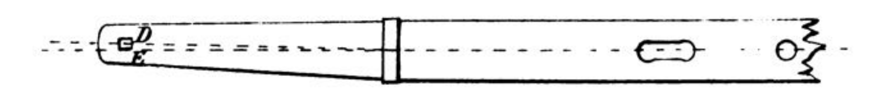
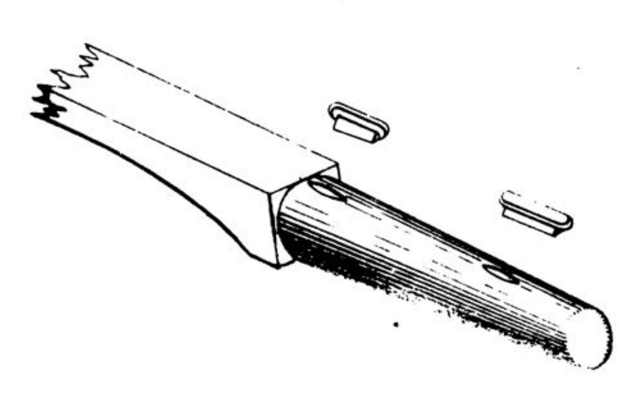


FIG. 3



the base of the arm to the straight edge. This manner of reckoning the hollow, though practically convenient, is not very correct, as it takes into account the amount of cone of the arm, which varies in the different classes and has nothing to do with the hollow, and further, measures it with reference to the pipe box instead of to the length of the arm proper. The amount of the hollow is always sufficient, notwithstanding the conical form of the arm, to point the latter downward, which has the effect of relieving the washer and linch-pin of the pressure which the nave would otherwise have against them, due to the conical form of the wheel and its conseqnent tendency to roll outwards from the carriage.

The lead of the arm.

In addition to the downward inclination, an inclination to the front, termed the "lead," is given to the axletree arm for the purpose of placing the front part of the wheel as, in revolving, it approaches the ground more in the direction in which the carriage is travelling, and from which the dish of the wheel and hollow of the axletree arm cause it to deviate. The lead thus causes the wheel to meet any obstacle which opposes it, more directly as regards that spoke on which the stress, due to the resistance of an obstacle, happens mainly to fall: in fact, it does for that spoke what the hollow does for the lower spoke. The amount of the lead has been empirically fixed at $\frac{1}{16}''$ in the length of the arm, or rather the length of the pipe box for all axles. It is expressed in parts of an inch and measured as the perpendicular distance D, E, from a central point D, Fig. 2, Plate VI., distant from the shoulder the length of the pipe box to a line in the same horizontal plane drawn parallel to the axis of the body.

Practically the lead is measured by a gauge or by means of a straight edge.

The lead, in a similar manner to the hollow, assists in relieving the pressure against the linch-pin.

Lining out a wheel.

It will be seen from the preceding remarks upon the hollow and lead of the axletree arm, together with what has been said previously on the construction of the wheel, that in planning a wheel, after the general dimensions have been fixed, the first thing to be determined is the amount of the dish and of the strut to be given, from which follows the amount of the hollow and of the lead of the arm, and then the amount of the bevel of the sole of the wheel from that of the hollow.

CHAPTER V.—CLASSIFICATION, CONSTRUCTION, AND REPAIR OF AXLETREES.

Classes of axletrees.

Axletrees are divided into the same classes as wheels, according to the size of the arm; the classes are, therefore, first, second, third, and special, those of the first class being stronger than those of the second, and of the second than of the third. Axletrees of either of the first three classes are identical, in so far that any wheel of the same class will fit upon their arms, but by reason of other dimensions, such as the length between the arms, they may not actually be interchangeable for any particular carriage. In the special class each axletree has its own particular sized arm.

Patterns.

Axletrees may also be considered of two different patterns, one for use with O.P. wheels with wood naves, and the other with Madras pattern wheels.

Parts of an axletree.

Axletrees, as already said, are made of wrought iron; the arm is that part which enters the pipe box of the wheel; the part between the arms is termed the body, and those portions of the body immediately adjoining the arms, the shoulders.

Table of O.P. axletrees.

The following are the principal O.P. axletrees :—

Class.	Nature.	Weight.			Length between shoulders.		Length of arm to linch-pin hole.
		cwts.	qrs.	lbs.	ft.	in.	in.
I.	Siege	1	3	9	3	$4\frac{1}{2}$	$16\frac{5}{8}$
II.	Carriage, 10 and 8 inch mortar and limber	0	3	20	3	0	14
	Cart, trench	0	3	9	3	0	"
	Field	1	0	17	3	8	"
	Wagon, siege	1	0	2	4	5	"
	Wagon, platform, fore	1	0	22	3	9	"
III.	Cart, hand	0	1	21	3	$3\frac{1}{2}$	$9\frac{3}{8}$
	Carriage, 6 pr. B.L.R.	0	1	$15\frac{1}{2}$	2	$9\frac{1}{2}$	"
	Carriage, 6 pr. B.L.R., special; Cart, forage	0	2	$2\frac{1}{2}$	4	2	"
	Wagon, G. S. (equirotal)	0	2	$6\frac{1}{2}$	4	$8\frac{1}{2}$	"
Special	Barrow, ambulance and store, China pattern	0	0	$15\frac{3}{16}$	2	$0\frac{1}{8}$	$6\frac{3}{8}$

Construction of the O.P. field axletree.

Taking the field axletree as the most common of the O.P. axletrees, it may be described as follows :—

The "hollow" or downward inclination of the arm amounts to ·437″, and the "lead" or forward inclination to ·062″; both which inclinations are included in the expression the "set" of the arm. Each arm is pierced with a rectangular linch-pin hole 14″ from the shoulder, measured on the upper side; on the under side where the arm takes the bearing of the pipe box, it is "steeled" (Fig. 3, Plate VI.), that is, small bits of steel let into it to prevent wear by the hardened cast iron of the box; these bits of steel are themselves hardened by heating the arm when finished and plunging it into cold water.

The body of the axletree is rectangular in section, $1\frac{1}{2}$″ deep by $3\frac{3}{4}$″ wide at the middle, and 3′ 8″ long, which latter measurement to be strictly correct, should be taken along the centre of the lead or front side. The body is drilled with three holes, one in the centre circular, and one on either side oblong, to receive bolts from the carriage. The side holes are elongated to suit the positions of the side bolts, which vary in different carriages with which the axletree is used; when a bolt is passed through the hole the space to the side of it is plugged with wood.

From necessity of manufacture the axletree is made in two parts, which are welded together; it is marked with the broad arrow and painted, if a spare axletree, lead colour in three coats, if for a particular carriage, with whitelead on those surfaces of the body which come in contact with the wood, previous to its being placed in the carriage, the

remaining surface, except the arms, which are left bright, being after painted as part of the carriage.

The following are the axletrees for use with Madras pattern wheels :— **Table of N.P. axletrees.**

Class.	Nature.	Weight.			Length between shoulders.		Length of arm to linch-pin hole.
		cwts.	qrs.	lbs.	ft.	in.	in.
I.	Sling wagon, iron, to 7 tons	—			4	4¾	12·628
I.	Siege	—			3	8½	,,
II.	Cart, S. A. ammunition	0	3	24	4	1½	11·378
II.	Cart, spring, iron frame (Perkyn's)	0	3	26	4	0½	,,
II.	Field	1	0	9	4	1½	,,
II.	Wagon, R.A., fore	0	3	22	4	0·9	,,
II.	Wagon, R.A., hind	0	3	22	4	0·55	,,
II.	Wagon, G. S., iron frame, spring, heavy; Wagon, bakery; Wagon, bread and meat — fore	0	3	26	4	0·5	,,
II.	Wagon, G. S., iron frame, spring, heavy; Wagon, bakery; Wagon, bread and meat — hind; Cart, tip, iron frame; Cart, spring, iron frame	0	3	26	4	0·9	,,
III.	Carriage, Gatling and limber	0	3	1	4	3·2	9·733
III.	Cart, spring, iron frame	0	2	26	4	2·6	,,
III.	Wagon, G. S., iron frame, spring, light; Wagon, ambulance, II. — fore	0	2	9	4	3·6	,,
III.	Wagon, G. S., iron frame, spring, light; Wagon, ambulance, II. — hind	0	2	9	4	3·2	,,
III.	Wagon, G. S. II., fore	0	2	24	4	8·6	,,
III.	,, ,, hind	0	2	24	4	8·2	,,
III.	Wagons, R.E., fore	0	2	20	4	10·5	,,
III.	,, ,, hind	0	2	20	4	10·2	,,
III.	Carts, R.E.	0	2	6	4	2·2	,,
Special.	Carriage, 7-pr. bronze of 224 lbs., or steel of 200 lbs.	0	1	14	1	5·5	7·00
Special.	Carriage, 7-pr. bronze of 200 lbs., or steel of 150 lbs.	0	1	10	1	5·5	8·00

Construction of the N.P. field axletree.

The following is a description of the N.P. field axletree, which may serve as an illustration of the construction of all axletrees for Madras pattern wheels :—

The arms are the same cone as the O.P. field axletree, and the same diameter adjoining the shoulder, but shorter, being but 11·378″ instead of 14″ from the shoulder to the linch-pin hole on the upper side. The amount of the lead of the arm is ·062″, and of the hollow ·4″. The arms are not steeled, as the hardened steel would soon wear away the metal pipe boxes of the wheels.

The body is rectangular in section, measuring 1½″ × 3¼″ near to the centre, which is of increased size round the bolt hole. The shoulders have a collar or cylindrical surface turned upon them, which enters the inner flange of the nave of the wheel.

The axletree is marked and painted in the same manner as the O.P. axletree.

The hind axletrees for the G.S. wagon, spring, heavy, and for the bakery and bread and meat wagons, though the same in weight, &c., are not interchangeable on account of the different position of the butterfly flaps for the attachment of the springs.

The third class axletrees for the engineer and transport carriages are made with an enlargement at the base of the cone of the arm. Plate V.

The arm of the axletree for the carriage of the 7-pr. of 224 lbs. is the third class arm shortened.

Perkyn's axletree.

The arms of the axletree used with the Perkyn's wheels are case-hardened.

Examination and repair of axletrees.

A broken axletree* may be re-welded in one field forge, though more readily by using two; care must be taken in the operation to preserve the proper length of the body, so as not to alter the track of the wheels.

The arms of an axletree require occasional examination as to their set, and to see that they have not worn away too much at their bearings. The set of an arm is tested by means of a straight edge, and should it require alteration as to set, it is given by laying the arm in the required position upon an anvil and striking the body of the axletree carefully at the shoulder.

If an arm has become worn away at its inner bearing a piece can be welded in at that part, the arm being worked to the proper form during the operation and afterwards brought to accurate dimensions by filing; it is, however, a nice operation and can only be undertaken by a skilled workman. If too much worn at its outer bearing, the arm may be heated and upset at the point, then filed to correct dimensions and the linch-pin hole extended to give the wheel sufficient room.

Should the shoulder of an axletree be worn, so as to give the wheel too much play, it may be remedied by upsetting the arm, as just mentioned, squaring the shoulder, and then drawing out the body a little, if required, to bring the track of the wheels correct.

In any case of such excessive play of the wheels, due to wear of the shoulders of the axletree, ends of the metal pipe box, or faces of the washers, it may, however, be simply removed by the addition of plain washers of the requisite thickness, either of iron or of leather.†

The steel bearings of O.P. axletrees frequently require renewal or rehardening. The former is done by cutting a hole with a cold chisel in the old steel, welding a new bit into it, then accurately filing it to gauge, and finally hardening it by heating to a red heat and plunging it into cold water: the latter, simply by heating the bearing points and plunging the arm into cold water.

Linch-pins.

Linch-pins are classed in the same manner as axletrees, and in either of the first three classes the same linch-pin will serve, whether the axletree be one for Madras pattern wheels or not. They have hitherto been made of wrought iron for all carriages, but for future manufacture will be of steel for field artillery carriages, which linch-pins will be stamped with the letter "S," to distinguish them.

The body of a linch-pin is rectangular in section, having a slot at the lower extremity for a leather tie, or, as recently approved for the army service corps and regimental transport, for a steel keep-pin. The head of the linch-pin is flat at the back and in continuation of the body, but on the face it has a notch, so that the pin can easily be knocked out should there be any difficulty in withdrawing it from the axletree arm.

Linch-pins occasionally require straightening, for which purpose they must first be slightly heated; they are also liable to be worn by the

---

* Whether broken in the body or in the arm.

† Much play under a Brandling shaft is particularly objectionable.



washer, in which case they must be reformed to bring them straight at the back.

Washers.

The washer prevents the nave of the wheel working against the linch-pin. Washers are classed in the same manner as axletrees, and in each of the first three classes are special for axletrees used with wood-naved wheels, and for those used with Madras pattern wheels. Washers are also "plain" or "drag" washers, the latter being formed with a loop to take the hook of a drag rope when required. Formerly, as a rule, drag washers were placed only upon the hind axle of carriages requiring them, but now, for the sake of simplicity of equipment, they are placed upon both fore and hind axle.

The washer for siege limbers, which are fitted for four-horse draught, differs from other drag washers in having a second loop formed upon it to receive the hook of the outrigger stay; such are termed "loop" washers.

Grease.

The grease used with all axletrees and wheels is that known as "Fenner's."

SECTION II.—FIELD ARTILLERY CARRIAGES.

CHAPTER I.—PRINCIPLES OF CONSTRUCTION OF FIELD ARTILLERY CARRIAGES.

In considering the construction of field artillery carriages, it will be well first to review those principles which, more or less, must be carried out in the building of all in common, and then to make a few remarks upon the particular requirements which govern the details of construction of the various descriptions of carriages.

ESSENTIAL QUALITIES.

The following qualities may be looked upon as the desiderata in a field artillery carriage, viz., "mobility," that the carriage may be brought rapidly into any required position or change of position; "stability," that in any movement the carriage may be required to make, even if the ground is tolerably uneven, it may not overturn; "strength," "durability," and "simplicity" are essential qualities which require no comment; and, lastly, "convenience of transport" must of necessity be desirable in a country like Great Britain, with numerous large and distant colonies.

The first and chief point, then, to be kept in view in the construction of all field artillery carriages is "mobility," for without possessing this quality in a very high degree they would be comparatively worthless.

In the following remarks the question of the advisability of employing a two- or four- wheeled carriage will not be entered into, it being assumed that the nature and purpose of the load compel the latter, which is further the best for draught though the less advantageous for wheeling. Also, in all cases, the mode of draught will be taken as shaft draught, being that adopted in the service, as placing the carriage more under control in manœuvring than pole draught, and as being more advantageous for the wheel horses.

Mobility.

1. Mobility.—The "mobility" of a carriage is influenced by several things, viz., by the "traction" (commonly termed the "draught") or

amount of power requisite to put it in motion and keep it in motion, by its capability of reversing, and by its power of passing obstacles.

To render, therefore, a carriage mobile, "the draught must be as light as possible." This necessitates, in the first place, the load being a minimum, that is, the weight of the gun or ammunition, &c. to be carried being given, the weight of the carriage a minimum ; and, in the second place, that the load be properly distributed over the axles.

Before passing on to the other points which affect the draught, it is to be noticed that the distribution of the load depends upon the relative diameters of the fore and hind wheels, and upon the fact that the traction of the fore carriage, taken by itself, is usually more difficult than that of the hind, because the fore wheels make, as it were, the tracks, and in so doing reduce the height of any obstacles for the hind. These considerations point to the reduction of the load upon the fore axle as compared with that on the hind. But, on the other hand, the fact must not be lost sight of, that if too much weight be thrown on the hind axle relatively to the fore, it will cause the hind wheels to sink too much in yielding ground, and thereby (though the decrease of weight on the fore axle tends, as before, to lighten it) to increase the draught on the whole.

Again, for lightness of draught the axles must be of such length as to give the same track to both fore and hind wheels, in order that, as above, the fore may in doing their own work also assist the hind. The diameter of the wheels must also be a maximum, and that of the axletree a minimum, which, together with other necessary conditions in the wheels and axles, have been noticed under that head. As already stated, the diameter of 5 ft. has been fixed upon as that most suitable for the field wheel.

Lastly, that the draught may be light, the point of the attachment of the traces must be the most favourable, that is, as regards height from the ground, it must be such as to give the most advantageous inclination to the traces. The point of attachment to the horse, viz., the collar, being fixed, experience has shown that this inclination should be about $6\frac{1}{2}°$.

The carriage to be mobile must, in addition to being light in draught be "capable of wheeling or reversing very short," that is, not only must the carriage be of a minimum length, but the angle through which the fore carriage can sweep must be as large as possible, which latter mainly depends upon the diameter of the fore wheels and details of construction of the body of the carriage.

The mobility of the carriage is influenced by what may be called "its power of passing obstacles," which point, so far as the wheels and inclination of the traces are concerned, may be considered as included under "lightness of draught ;" but beyond this is influenced by the mode of connexion of the fore and hind carriage, which should be such as to admit of vertical motion of the fore carriage about the point of connexion, so that the fore carriage may move in that direction independent, to some extent, of the hind carriage. The distance between the axles also slightly affects the power of the carriage to pass obstacles, but need hardly be taken into account, as the length between the axles best suited for passing certain obstacles will not be the best for passing others. And here it may be as well to remark, with regard to the distance between the axles, that it does not in ordinary cases affect the traction, providing that the relative position of the centre of gravity of the load as to the axles remains unaltered.

Stability.

2. Stability.—"Mobility" in a field artillery carriage would not, so to speak, e perfect unless accompanied by "stability," which point has

therefore next to be considered. Stability is influenced by the number of points on which the carriage rests and by the vertical and horizontal position of the centre of gravity with regard to those points. The carriage being supposed on the level, the first-mentioned distance should be as small as possible (which latter, with convenience of width governs the track) to yield maximum stability. This will be readily understood by supposing a carriage placed upon the level and a vertical drawn through the centre of gravity, then the carriage tilted through a certain angle; when it will be seen that the higher the position of the centre of gravity, the greater the distance through which it has moved, and therefore the more nearly will the vertical then drawn through it be to falling outside the bearings on the ground. Again, with regard to the horizontal position of the centre of gravity from the bearing points, it is evident that the further it is from them, the greater moment the weight, acting at that centre, has to resist any force tending to overturn the carriage.

Stability in wheeling or reversing will further be influenced (setting aside the weight of the carriage, already fixed at a minimum by the consideration of mobility) by the height and mode of connexion of the fore and hind carriages, as well as by the height of the attachment of the traces to the fore carriage.

That the carriage may be stable in any position of rest or of motion to the front, it is simply necessary that the vertical through the centre of gravity should fall within the figure formed by joining with straight lines the points upon which it rests. In field artillery carriages, the stability is considered sufficient when the upsetting angle for the carriage packed is about 35°; that is to say, the vertical falls outside the points on which the wheels rest and the carriage overturns, when it stands upon a side incline exceeding 35°.

Strength and durability.

3. Strength and durability.—The next points to be taken into consideration in the building of a carriage are "strength" and "durability." The material used should be the strongest consistent with lightness; the scantling of each particular part being, in the same view, at a minimum consistent with the stress which the part may be called upon to bear. The material should also be such as will stand well the effect of shot striking it, the action of climate, &c., and should not be liable to deteriorate when kept in store.

Of late years, wrought iron has superseded wood as a material for carriages, being much more durable, and, comparing it with English oak, it is but slightly heavier for the same strength: because, from its nature its mass can be better disposed to withstand any given stress. Wrought iron, however, is not so elastic as wood, and therefore will not absorb so much of any stress as the latter; and, again, has the defect of suffering readily deformation, and thus loss of strength through loss of form. This latter defect sometimes necessitates the scantling of the iron being made of greater dimensions than mere strength to resist a particular stress would require.

Simplicity.

4. Simplicity.—"Simplicity" of construction in the carriage is the next quality to be kept in view; that is to say, as far as possible, there should be nothing complicated nor likely to get out of order: neither should any part be such that, if damaged, it could not readily be repaired. Again, looking at the carriages in the aggregate, the parts and fittings should, as far as possible, be interchangeable.

Transport.

5. Transport.—"Convenience of transport" is a point which must not be lost sight of in building the carriage: in view of which, it should admit of readily being taken to pieces and conveniently stowed on board ship.

Length. Lastly, it is to be noted that the total length of the carriage should be at a minimum; not only, as before mentioned, for mobility, but that in column of route it may cover as little ground as possible.

A few further remarks may now be made upon the particular requirements of the gun carriage, &c.

The Gun Carriage with Limber.

The gun carriage. The present form of gun carriage has been arrived at, as fulfilling the foregoing conditions, and also as convenient for bringing the gun into, and serving it when in action; as furnishing a stable carriage for the gun in action; as allowing of a supply of ammunition and stores being carried with the gun, readily accessible for use; and as admitting of a proportion of men being carried upon the carriage in addition to its proper load.

With regard to the mobility of the gun carriage, it is to be remarked that it has an advantage not possessed by ordinary carriages, viz., of having fore wheels of equal diameter to the hind, yet locking through a considerable angle. Further, the connexion of the fore and hind carriage may be said to be perfect as regards passing obstacles, for the vertical as well as the horizontal motion of the former is very independent of the latter.

In point of strength and durability not only has the gun carriage to be able to withstand the strains to which it may be exposed as a travelling carriage, but it also must have sufficient strength to withstand the action of the gun when fired at the most hurtful elevation.

In investigating the effect of the discharge of the gun upon the carriage, we may consider that discharge as simply producing a force or blow upon the bottom of the bore, and acting in the line of the axis of the gun, though it is questionable whether the action is actually so simple. The gun, that is its weight, charge, &c. are supposed in the following remarks to be given, and constant, and unless the contrary is specified, the carriage standing on the level and the gun laid at any angle of elevation or depression. From the symmetry of the gun and carriage with regard to the vertical plane through their longitudinal axes,* we can further take the whole of the forces to be spoken of as acting in that plane. Taking then the single force applied at the bottom of the bore, we may conceive it resolved into two components, one horizontal, the other vertical. Now a proportion only of the single force or its components is transmitted from the gun to the carriage; part, depending in amount upon the weight and thickness of metal of the gun, being expended upon the former.

Again, of the proportion transmitted to the carriage, the whole is not expended upon the carriage, but a small part transmitted to and expended upon the ground, the amount depending upon the nature of the latter. Now the gun is supported upon or attached to the carriage at two points, viz., the trunnion holes and the bearing of the elevating screw on the trail, but the attachment is not rigid, for the gun is movable about the axis of its trunnions and is hinged to the elevating screw, the latter being also movable in a vertical plane round its bearing on the trail.

Taking, therefore, a certain horizontal and vertical force as transmitted from the gun to the carriage, we see from the nature of the connexion between the two latter that the point of application of these forces is at the trunnion holes.

---

* It is not only convenient but necessary that these axes should lie in the same vertical plane to prevent the carriage receiving a twist horizontally.

The horizontal component decreases as the angle of elevation or depression with the horizontal at which the gun is fired increases. It exerts itself upon the carriage, as a whole, in two ways, viz., in giving it a motion of translation to the rear, and a twist or tendency to constrained motion about the point of the trail, as that point may be regarded for the instant as fixed. Hence, to render the effect of this component as little hurtful to the carriage as may be, the latter should in itself oppose the motion of translation as little as possible, which amounts to saying that its inertia, and consequently its weight, should be a minimum (the latter we have already seen, mobility also demands), while to reduce the twisting strain to a minimum the trunnion holes should be as low as other considerations will admit.

The vertical component will act in an upward or downward direction, according as the gun is fired at an angle of depression or elevation with the horizontal, and will increase with the angle. If upward, it will tend to tear the carriage asunder, if downward to crush it, the latter being that which tells most upon the carriage on account of the resistance of the ground upon which the carriage bears; in addition to this, it will, as well as the horizontal component, have a moment with respect to the bearing point of the trail, but if it is acting downward, in an opposite direction to that of the latter.

The body of the carriage is supported upon the ground at two points, viz., the axletree arms and the point of the trail; when, therefore, the blow of discharge is transmitted to the carriage, if the vertical component act downward, its brunt will be borne mainly by the axletree, because the axis of the trunnion holes lies vertically very near the axis of the latter.

If the vertical component acts upwards, the resistances of the ground will not then be called into play, but the weight of the carriage acting downward at its centre of gravity will offer some resistance, the tendency being, as before said, to tear the carriage asunder. When the vertical component acts downwards and the resistances of the ground are called into play, they will in general be less in total amount than the component itself, the excess of the latter being expended upon the ground. This excess will vary with the hardness of the ground, and the carriage will be saved, according as the latter is more or less yielding. Just in the same manner the ground, by its nature, will influence the recoil, and, as before mentioned, in doing so influence the amount of the horizontal component spent upon the carriage, and the portion transmitted to and expended upon the ground.

In a similar manner the slope of the ground to the front or rear, by influencing the recoil, affects the destructive effect upon the carriage.

The elevating screw is called upon to sustain a certain strain, upon discharge, due to the trunnions having some play in the trunnion holes, and therefore resting previous to discharge upon the lower points of those holes, that is, upon points below the axis of the gun, which is the line of action of the force of discharge; consequently the latter has a moment with respect to the bearing points, which is borne by the screw and through it by the trail.

It only remains to be noticed with regard to the force transmitted from the gun to the carriage, that in guns having the axis of the trunnions below the axis of the piece, other things equal, the blow upon the screw and the trail at the bearing of the screw is more severe than in guns in which the axes intersect, because the impulse on the bottom of the bore, acting in the line of the axis, has a greater moment round the bearing points of the trunnions.

Carriages having a detached elevating screw are liable to a second

and destructive blow upon the trail from the breech of the gun and the screw falling back to their place, after the rebound of the trail from the ground has thrown them up.

As regards serving the gun in action, it is to be observed that the form of carriage adopted is admirably adapted for laying the gun, admitting of ready motion being given to the latter in a plane perpendicular to the axis of the trunnions and to the carriage itself, and therefore to the gun in a plane at right angles to the former.

As to furnishing a stable carriage for the gun in action, the form adopted gives three points of support, the vertical through the centre of gravity falling between them, and hence a stable carriage. Not only so, but a carriage that is stable when the gun is fired, as the axis of the gun lies in the vertical plane (the wheels being on the level) containing the centre of gravity of the system, while the rear point of support of the carriage is in the same plane and at a sufficient distance from the centre of gravity.

It now remains to make a few remarks upon the parts of the gun carriage in detail.

The wheels and axletree have already been treated of, and it only remains to mention, with regard to the destructive action of the gun upon the carriage, and axletree in particular, that, looking at their inertia, the weight of the wheels should be a minimum (as well as for mobility).

The scantling of the parts has been arrived at from experience and experiment, as well as from scientific considerations, being always kept at a minimum consistent with proper strength for the sake of mobility, which considerations in the following remarks is understood to be kept in view.

The wooden axletree bed, hitherto used, served as a convenient means of securing the axletree to the carriage body, more particularly in wooden gun carriages; it also distributed the load in travelling and the strain in firing more uniformly over the axletree, serving by this means and by its own additional strength to admit of the axletree being made lighter than it otherwise could be.

In iron carriages, however, it gives no additional facility of construction, and though it has the advantage of assisting the axletree to some extent, it is a questionable advantage, so that in this case it would appear to be superfluous, and it may even be said to be a faulty form of construction; a compound axletree, as it were, being made of two substances differing so much in elasticity as wood and iron; and further, the material having the greatest elasticity placed to receive the pressure or blow; in fact, the iron may be broken before the full strength of the wood has been called into play. For this reason, in iron carriages of the future it will be dispensed with and the axletree modified.

In form the bed is of the same section throughout, but not rectangular, because while the upper surface is parallel to and the sides perpendicular to the under surfaces of the brackets into which it is housed, its under surface must be such as to be parallel to the ground when the trail is upon the limber hook, in order that the lower surface of the axletree may be parallel to the same, that being the position of the axletree for which the "lead" and "hollow" are calculated.

The dimensions of the bed depend upon the axletree, its length being the same as that of the body of the latter, its depth being regulated by the height considered necessary to be given to the axis of the gun, (which is governed by the general rule, that the gun should be able to fire over a parapet 3′ 6″ high at 5° depression,) and its width such

that it may be able to retain a good hold upon the axletree without giving way itself.

The height of the brackets must be at a minimum consistent with the maximum elevation and depression necessary for the gun, viz., about 15° elevation or 10° depression being given when required, and also to give (in wooden gun carriages) room for sufficient depth of housing over the axletree bed.

The height must be kept, as stated, at a minimum, because the deeper the brackets the stronger and therefore heavier they must be in themselves, and again, because the higher they are, the less will be the stability of the system.

With regard to the position of the trunnion holes in the brackets, it is ruled by the consideration that it must not be so far back as to make the weight on the limber hook, the position of which is in a measure fixed by other things, excessive, but such as easiness of lift in unlimbering demands, and, so far as it may be taken into account, of correct distribution of the load on the fore and hind axles. At the same time the position of the trunnion holes must not be so far forward as that when the carriage is unlimbered and the gun fired, the trail would rebound from the ground and the system turn over to the front. Neither should the weight upon the limber hook be so little as, in travelling over rough ground or up an incline, to cause a succession of heavy blows by the trail against the key securing it. In practice, in gun carriages for the lighter field guns, the axis of the trunnions, the gun being unlimbered and on the level, and the axis of the axletree of the carriage are very nearly in the same vertical plane, which with the construction of the trail, &c. causes the point of the trail to press upon the ground with a force equal to about half its own weight.

In the carriages for the heavier guns, it is found impossible to combine the required conditions in one set of trunnion holes, and it becomes necessary to have one set for the gun in travelling and another in firing.

The dimensions of the trail are fixed as follows :—Its length chiefly depends upon the influence it has upon the recoil when the gun is fired, and therefore upon the extent to which it is considered desirable to check that recoil, bearing in mind, as before mentioned, that the more the recoil is checked the greater will be the destructive effect upon the carriage. In this view experience has shown that the angle which the trail makes with the ground should not exceed 22°. Setting this point aside, the length of the trail must be sufficient to prevent any danger of the gun and carriage turning over to the rear about its point on firing. Minor considerations which affect the length of the trail are, that it must be long enough to admit of easy access between the fore and hind wheels, and not so long as to make the fore and hind axles unnecessarily far apart. As we have seen, it is where the elevating screw is supported that the greatest breaking strain comes upon the trail, and where therefore its cross section must be the greatest, depending not only upon the amount of the blow communicated through the elevating screw, which is exceedingly difficult to calculate, but also upon the distance from the elevating screw to the point of the trail. Towards the point of the trail, though the cross section may be decreased with reference to the blow on the elevating screw, it must be such as to be able to withstand any lateral strain the trail may be liable to be exposed to, for instance, the jamming of the fore wheel against it in locking, and also any twisting strain in going over rough ground.

The limber is fitted to carry the supply of ammunition which accompanies the gun. Three points about it deserve notice, viz., its load, the position of the limber hook, and the point of attachment of the traces.

The load on the fore axle, as before mentioned, should be less than that upon the hind axle, but the amount of difference on the gun carriage must of necessity be more or less modified by the quantity of ammunition which is considered absolutely necessary to be carried with the gun.

The position of the centre of gravity of the load must always be such that the vertical through it will fall in front of the axletree, that there may be no tendency to rotation to the rear; otherwise, the position of the load must be such that when combined with the effect of the distribution of the remainder of the whole load, it will throw a sufficient amount of weight and no more upon the shaft horse's back.

The ammunition being carried in boxes facilitates stowing on board ship, &c.

The height of the limber hook from the ground is fixed by convenience of lifting the trail, for unlimbering and limbering up; its position between the axles, by the length given to the trail, the proportion of the total load to be thrown on each axletree, and, as far as possible, solidity of attachment to the body of the limber.

The considerations governing the point of attachment of the traces have been mentioned before, under the head of lightness of draught, in respect of mobility.

The Ammunition Wagon.

Ammunition wagon.

The wagon must be able to accompany the gun over any ground the latter may have to pass, therefore the general principles of mobility, &c., apply equally to it, and the present form of ammunition wagon has been arrived at as best carrying out these principles and the particular purpose for which it is intended; the parts so far as possible being interchangeable with those of the gun carriage.

With regard to the distribution of the load upon the axletrees, the arrangement of the ammunition in boxes admits of the approved proportion, viz., 1 : 2, being more conveniently and more nearly approached than in the gun carriage.

Nothing requires to be said upon the parts of the wagon in detail. What has been said about the parts of the gun carriage, viewing it as a travelling carriage, applies to it, the perch in one corresponding to the trail in the other.

Remaining Artillery Carriages.

Other carriages.

The remaining carriages of a battery were formerly constructed on the same plan as the gun carriage and ammunition wagon in order that they might be able, when required, to surmount difficult ground equally with them. Such limber wagons are now, however, replaced by a general service wagon of the same form as the transport wagon, the principles of construction of which will be treated of in another place.



CHAPTER II.--WOODEN FIELD GUN CARRIAGES AND AMMUNITION WAGONS.

Field gun carriages and ammunition wagons being no longer constructed of wood, a brief notice of the more recent wooden carriages, many of which are still in existence, will suffice ; they are as follows :—

Table.

Nature.*	Weight.		Tonnage.
	Empty.	Packed.	
	cwts.	cwts.	tons.
6-pr. B.L.R. carriage, with limber complete -	$11\frac{3}{4}$	$15\frac{3}{4}$	2·7
" wagon " " -	15	19	2·6
" carriage, special pattern " -	$16\frac{1}{4}$	$21\frac{1}{2}$	4·2
" wagon " " -	22	$33\frac{1}{4}$	4·1
9-pr. B.L.R. carriage, with limber complete -	21	$31\frac{1}{4}$	4·4
" wagon " " -	28	$40\frac{1}{4}$	6·5
12-pr. B.L.R. carriage " " -	$23\frac{1}{2}$	37	4·48
" wagon " " -	28	$43\frac{1}{4}$	6·5
20 pr. B.L.R. carriage " " -	28	$48\frac{1}{2}$	5·18
" wagon " " -	$28\frac{3}{4}$	$38\frac{1}{4}$	6·5

* The 40-pr. is included and described with the siege artillery carriages. The ammunition wagon accompanying it is the same as the 12-pr., or else the 18-pr. S. B. wagon converted.

The 12-pr. B.L.R. gun carriage being the most common of the above gun carriages, it is convenient to take it as a type of the others and describe it first, together with its limber and the ammunition wagon.

12-pr. B.L.R. gun carriage.

The 12-pr. gun carriage consists of the following principal parts, namely, the trail, two brackets, the axletree, axletree bed, and wheels.

The trail is of oak, usually in one piece, but sometimes in two joined longitudinally ; it is fitted with a trail plate with steeled eye for attachment to the limber. The brackets are of oak or elm, attached to the trail by dovetailed housings and by three bolts. The axletree bed of oak is housed both into the trail and brackets, and is secured by axletree bands, which, together with yoke bands and coupling plates, also hold the axletree in the bed. The axletree is the field axletree, giving the wheels, which are the O.P. light field, a track of 5′ 2″.

The carriage is fitted with a traversing arrangement, which consists of a metal saddle carrying the gun in trunnion holes, and secured by capsquares. This saddle slides in dovetailed slots in the trunnion plates, and is traversed by means of an iron lever pivoted upon the trail. The lever is worked by a traversing screw resting in bearings on the brackets, and fitted with a hand wheel. Iron cleats or stops are fixed upon the trail, and allow of $1\frac{1}{2}°$ right or left deflection being given to the gun.

The other fittings of the carriage are, a socket or pan for the elevating screw, a chain with hook for securing the gun in travelling, breast chains, trail handles, locking plates, jack plates, and also fittings for carrying side arms, axletree boxes, drag shoe, and small stores.

The articles belonging to the carriage are an elevating screw, side arms, axletree boxes, and a drag shoe with chain. The screw is that known as the "ball-and-socket" pattern ; it is attached to the gun by a bolt and pin, and worked by handles on a wrought-iron collar fixed to a metal nut, which is in the form of a ball. The side arms are a traversing handspike and sponge of ash, the head of the latter being covered with a coating of woven hemp and canvass, tied on, and protected



when not in use by a canvass cap; the other end of the sponge stave is formed to serve as a rammer, and at certain points along the stave there are copper rings as marks. The axletree boxes are "right or near" and "left or off;" they are fitted to carry each two rounds of case and some small stores.

The field limber.

The limber for the gun carriage consists of a framework formed by an axletree bed and block of elm, a splinter-bar and three futchells of ash. A platform board of ash, and footboard of elm are secured over the front of the futchells, and a slat of ash to fill the space between the splinter bar and the footboard. To the back of the block a limber hook is bolted. The axletree and wheels are the same as in the gun carriage, the former being secured in the bed by bolts and by yoke bands with coupling plates. The limber is fitted for draught, for carrying ammunition boxes, entrenching tools, &c. in the same manner as the iron limber for the 9-pr. M.L.R. to be hereafter described.

The articles belonging to the limber are three ammunition boxes, "near," "off," and "centre," with a canvass cartouch for each of the two first mentioned. The boxes are the same in external dimensions and in general arrangement as those of the iron limber. The near and off boxes carry each 17 rounds of ammunition, an indian-rubber ring being placed under each shrapnel.

12-pr. B.L.R. ammunition wagon.

The ammunition wagon consists of a perch, two sides, and three platform boards of ash, two footboards and an axletree bed of elm, two fluted boards of teak, together with axletree and wheels, the same as in the gun carriage.

The perch and sides, each of the latter strengthened by an iron plate along its outer surface, and the former fitted with a nose plate with steeled eye for attachment to the limber hook, are housed across and bolted to the axletree bed. The axletree is secured in the bed by bolts and by yoke bands with coupling plates. The boards are fitted across the perch and sides, the fluted boards being placed between the platform boards for the ammunition boxes to rest upon.

The wagon is fitted with an axletree arm block of sabicu, shod with iron over the front footboard and front platform board, together with an elm block on the perch for carrying a spare wheel; the fittings for securing the boxes are similar to those on the gun limber; the remaining fittings are jack plates, locking plates, fitments for a drag shoe, and for carrying under boxes and stores.

The articles belonging to the wagon are six ammunition boxes, four canvass cartouches, four under boxes, a drag shoe with chain and spare lashings. The ammunition boxes are two "off," two "near," and two "centre;" the off and near are identical with those of the gun limber, except in the leather fittings, but the centre are shorter and of slightly different shape to the centre box of the limber. The under boxes are one for grease and four for horseshoes.

The wagon limber is the same as the gun limber; it has the letter "W" painted upon it for distinction.

9-pr. B.L.R. gun carriage, &c.

The 9-pr. gun carriage has a small transom between the brackets at the breast, and is not fitted with a traversing arrangement. Its axletree and wheels are the same as those of the 12-pr. carriage.

The limber and the ammunition wagon for the 9-pr. are the same as those for the 12-pr., the internal fittings of the boxes being different.

20-pr. B.L.R. gun carriage,

The 20-pr. gun carriage is fitted with a traversing arrangement, differing slightly in detail from that of the 12-pr. It takes the field axletree and the heavy field wheel.

The limber has also the heavy wheel, but with this exception is the same as that of the 12-pr. The ammunition wagon is the same as the

12-pr. wagon, except in the internal fittings of the boxes, which exception also holds good in the case of the limber boxes.

There have been carriages of two different patterns made for the 6-pr. gun, viz., the "service" pattern for the colonies generally, and the "special" pattern for use in Kaffraria; they are made of such foreign wood as is suited for the climate for which they are intended. Both patterns have third class wheels and axles; the wheels of the service pattern are 4′ 2″ in diameter, with a track of 3′ 10″, while the wheels of the special pattern are 5′ in diameter, and have the usual track for artillery carriages of 5′ 2″.

6-pr. B.L.R. gun carriages.

The limber for the service gun carriage consists of a simple frame, with a narrow platform board across the front, secured to an axletree bed. The axletree and wheels are the same as for the gun carriage. The limber is fitted for single draught with special movable shafts, and carries three long boxes, the off and near boxes open at the sides next the wheels, and are not fitted with guard irons.

6-pr. B.L.R. limbers.

The limber for the special gun carriage is similar to the field limber, but has third class wheels and axles, the same as its own gun carriage.

There have been two patterns of ammunition wagons for the 6-pr., corresponding to the gun carriages, both similar in construction to the 12-pr. wagon, and each taking the same wheels and axles as its own gun carriage. The service pattern carries but three boxes, the same as those on the gun limber; it has no axletree arm block for the spare wheel, but carries the latter on the perch. In both cases the same limber serves for the wagon as for the gun carriage.

6-pr. B.L.R. ammunition wagons.

CHAPTER III.—EXAMINATION AND REPAIR OF WOOD CARRIAGES.

The defects to be looked for in the woodwork are shrinkage, cracks, decay, worm, and general damage.

General defects.

Shrinkage and cracks are due to exposure to the sun, or from being kept long in a very dry store. The first-mentioned defect makes itself apparent by looseness of fitting of the parts or of the ironwork on the wood.

Decay is usually due to the penetration of moisture under the ironwork or in joinings; it is detected by using a hammer and pricker, as mentioned under the head of "examination of wheels."

Worm, if the carriages have been kept long in a dry store, is to be looked for in parts made of ash, and makes itself apparent by small pin holes, and white dust upon the surface.

The defects to be met with in ironwork, strapping, &c., together with the necessary repairs, will be treated of in the "repair of iron carriages."

With regard to the gun carriage, the trail should be closely examined at each side just behind the brackets, to see if there is any indication of splitting. If there is, the brackets must be removed, and the extent of the splitting ascertained, when it will generally be found that the cracks due to the concussion of firing have started from the housing of the trail over the axletree bed, and continued through the horizontal bolt holes. If not extensive, the splitting may be remedied by two bolts through the trail from the upper side, and nutted beneath. If the trail is much split it must be condemned, and as a consequence the whole

The gun carriage.

carriage, for, as a rule, in wooden carriages which are obsolete for future manufacture, when the cost of repair would exceed one-third of the original value, the carriages are condemned.

Extensive decay or damage in the trail will condemn it, but small damaged or decayed patches may be cut out and replaced by sound timber.

Shakes or cracks along the upper surface of the trail are not of consequence, but should be filled in, if small, by "stopping," the crack being first cleaned out and painted to make the stopping adhere. Large cracks must be filled in with wood of the same kind as the trail itself, the slips being painted and driven in while the paint on them is wet, and then secured by brads; when the paint on the slips is dry, stopping should be filled in to any remaining crevice. Very small cracks can be filled in with putty, being first painted over.

The brackets of the gun carriage are liable to work loose from firing, particularly at the screw holes in rear. If loose they should be removed, the axletree bed of necessity first, the joining surfaces painted, the old screw holes plugged up and new ones bored, and then replaced, the bolts and screws being well tightened. As a rule, decay or other damage in a bracket, unless small, will condemn it, in which case the old ironwork, if serviceable, should be used on the new bracket.

In replacing brackets care must be taken to keep the axis of the trunnion holes at right angles to the axis of the trail, namely, by getting a corresponding point at each trunnion hole equidistant from a point taken on the centre of the trail in rear of the elevating screw hole, and also, the wheels standing on the level, the trunnion holes should be levelled across.

The axletree bed should always be removed in making a thorough examination of a gun carriage, the axle being first taken out of the groove. If the bed is much decayed, split (which it is liable to be from the careless use of the jack as well as from firing), or shrunk, it must be condemned and replaced by a new one. Small shakes do not signify; if but slightly shrunk, shortening the axletree bands by upsetting them will be sufficient to tighten the bed in its position.

If the axletree, from the shrinkage of the bed and consequent increase in the depth of the groove, is not properly gripped, the under side of the bed may be planed down a little, and the axletree bands upset to correspond. Another and more expeditious way of remedying this defect is to pack a piece of painted canvas in the groove under the axletree, the groove being first whiteleaded. In replacing an axletree care must be taken to put it in with the "lead" to the front and to get it at right angles to the axis of the trail by making the points of the arms equidistant from the trail eye.

The limber.

In all repairs wherever two surfaces are brought into contact they must be painted with red or white lead or ordinary paint.

If there is any appearance of decay on examining the limber about the futchells, the boards should be removed and the former examined underneath. The axletree bed is dealt with as the bed of the gun carriage. The block is liable to be shrunk from the bed, and if so, it must be refitted, and the bolts tightened up.

The repair of shafts and boxes will be given under iron carriages.

The ammunition wagon.

In the ammunition wagon, if there is any appearance of decay or splitting in the perch or sides, the boards should be removed and the parts examined more particularly underneath.

The perch is liable to shakes and to longitudinal separation of the fibres from the twisting strain to which it is subjected when the wagon passes over very broken ground; such damage will entail

the condemnation of the perch, but not as a consequence of the whole wagon.

Painting and marking. Carriages repaired in the R.C.D. have the letter "R" and date of repair stamped upon them; if simply adjusted, the letter "A" takes the place of "R."

Painting after repair will be noticed in the repair of iron carriages.

CHAPTER IV.—IRON FIELD ARTILLERY CARRIAGES.

Table. The following table‡ gives the iron field carriages, including also the R. A. wagon, though strictly speaking it is a wood wagon.

Nature.	Weight.						Tonnage.
	Empty.*			Packed.†			
	cwts.	qrs.	lbs.	cwts.	qrs.	lbs.	tons.
9-pr. M.L.R. gun carriage, with limber complete. Mark I. (for R. H. A.).	22	0	19	35	2	26	4·079
9-pr. M.L.R. gun carriage, with limber complete. Mark I. (for F. B.).	22	2	12	36	0	19	,,
9-pr. M.L.R. gun carriage, with limber complete. Mark II. (for F. B.)	21	2	5		—		,,
9-pr. M.L.R. ammunition wagon, with limber complete. Mark I.	25	0	25	40	1	21	4·493
9-pr. M.L.R. ammunition wagon, with limber complete. Mark II.	24	3	17		—		,,
9-pr. M.L.R. gun carriage, with limber complete for India. Mark I. (for F. B.).	22	1	22	34	3	16	4·079
9-pr. M.L.R. gun carriage, with limber complete for India. Mark II. (for F. B.).	21	3	4		—		,,
9-pr. M.L.R. ammunition wagon, with limber complete for India. Mark I.	24	2	24	36	3	27	4·493
9-pr. M.L.R. ammunition wagon, with limber complete for India. Mark II.	24	2	9		—		,,
16-pr. M.L.R. gun carriage, with limber complete. Mark I.	24	2	4	42	2	4	4·079
16-pr. M.L.R. gun carriage, with limber complete. Mark II.	23	2	18		—		,,
16-pr. M.L.R. ammunition wagon, with limber complete. Mark I.	25	3	21	41	2	11	4·493
16-pr. M.L.R. ammunition wagon, with limber complete. Mark II.	25	2	7		—		,,
Gatling gun carriage, with limber complete. Mark I.	12	3	23		—		2·846
Forge wagon, with limber complete for India. Mark I.	28	0	1	38	1	14	5·450
Forge wagon, with limber complete for India. Mark II.	27	3	16		—		,,
Wagon, R. A. Mark I. - - -	21	1	10		—		4·137

* Side arms, but not spare wheel, included. † Spare wheel included.

‡ To this shortly will be added 25-pr. M.L.R. carriages; the gun carriage, probably, similar to the 16-pr., Mark II., but with elevating arc instead of screw, and the limber and wagon the same as the 16-pr. limber and wagon, Mark II.

Track. All the above carriages have Madras pattern wheels, with a track or distance, measured from outside to outside on the ground, of 5′ 2″.

Painting. They are, with their fittings, (except bearing surfaces, the points of the axletree arms, linch-pins and washers which are bright) and articles belonging to them (except side arms, elevating screws, bale hoops and canvass covers) painted lead colour and lettered in white, the woodwork receiving three coats of lead colour and the ironwork two coats of Pulford's black and then one of lead colour.

Marking. The body of each is stamped with a register number, the date of manufacture, and number of the mark or pattern : if a gun carriage on the point of the trail, if a limber on the rear of the bed, if a limbered wagon on the hind centre bracket under the footboard, and in the R.A. wagon on the hind earbed.

Method of taking tonnage. Before proceeding to describe these carriages it may be well to give the method of taking the tonnage of a carriage (which is equally applicable to any other article), namely, as follows:—

The movable parts, such as the wheels and shafts, &c., are taken off, and the body of the carriage laid upon the ground, right side up or otherwise as may be most convenient. The length of the longest part is then measured, as a guide for the least length of space which the carriage can occupy and the width of the widest part for the least width. These dimensions give the size of the rectangular base, upon which, over the body, the other parts are packed as closely as may conveniently be. When packed, the greatest height in feet multiplied by the length and breadth of the base in feet give the number of cubic feet occupied by the carriage, and the product divided by 40 gives the tonnage.

9-pr. M.L.R. Gun Carriage. Mark I.

9-pr. M.L.R. gun carriage. Mark I. (Plate VII.) Construction. This carriage will take either the 9-pr. M.L.R. wrought iron or bronze gun of 8 cwt., and also the 9-pr. M.L.R. of 6 cwt. It is formed of two bracket sides connected together by two transoms, two collar bolts, one rivet, and a trail plate ; an axletree bed with axletree and light field wheels.

A bracket side is constructed of plate iron riveted to the outer side of a frame of angle iron of the required form and made especially strong at that part where the trunnion hole is cut.

The front transom is of plate iron bent to form and riveted to the inside of the bracket frames, immediately in front of the recesses for the axletree bed.

The second transom is of plate iron with a piece of angle iron riveted along each side, through which it is bolted to the bracket frames a little behind the recesses for the axletree bed.

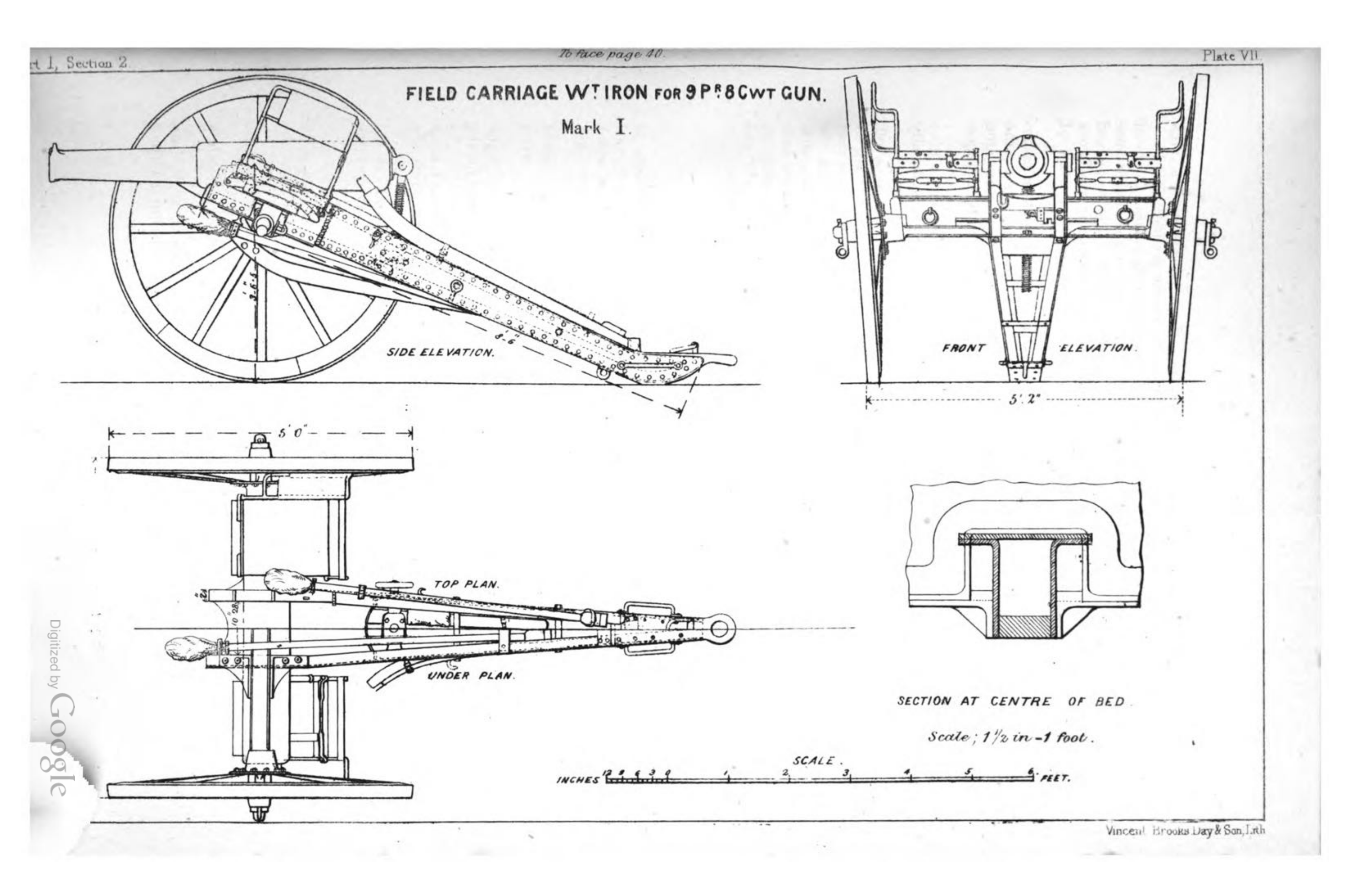
The collar bolts connect the brackets between the second transom and the point of the trail; their collars bear against the plates of the brackets and keep the latter rigidly apart.

The rivet connects the brackets at their points, where they are also united by the trail plate riveted to them. This plate is formed, as in wood carriages, of two jaws which project from an eye and embrace the points of the brackets, the under one taking the bearing of the trail upon the ground; the eye is steeled to prevent wear by friction on the limber hook.

The axletree bed is of wrought iron, constituting with the axle a beam of box-girder section (see Plate VII.)

The axletree forms the bottom of the box, a piece of angle iron riveted along each side of the body the sides, while the top is formed

To face page 40.



Vincent Brooks Day & Son, Lith

ELEVATING ARRANGEMENT FOR 9 PR R.M.L. GUN.

C

A

B

D

SECTION ON A B

SECTION ON C.D.

2.1.5
.5 PITCH

5.625

1.3125

7.75

H

SCALE

INS 12 9 6 3 0 1 2 FEET

Angerer Brooks Day & Son Lith

by a plate riveted upon the upper sides of the angle iron pieces. The top plate and angle iron are slotted to admit the bed into its recesses in the brackets, where it is secured by being riveted to the frames of the latter and by bracket stays in front and in rear riveted to itself and to the frames.

The arms of the axletree are of the second class, N.P.

Fittings.

The carriage has the following fittings, namely :—

Wrought-iron capsquares secured by keys.

Metal sockets to receive the trunnions of the elevating screw box and to support the spindle.

A staple with strap to secure the hand wheel of the elevating screw in travelling.

A handspike ring, shoe and pin on the point of the trail for securing the traversing handspike in action.

A sponge plate on the right bracket, a plate beneath the trail, and sundry staples with straps for securing the side arms; namely, a sponge on the right bracket, a traversing handspike on the left, and a spare sponge and handspike beneath.

A metal nut under the front transom to receive and staple with strap to secure a wadhook worm.

A lanyard hook on the left bracket.

Fittings for carrying axletree boxes, small stores, &c.

Fittings for a drag shoe and chain on the left side of the carriage.

Breast rings, trail handles, and a range plate.

Articles belonging to.

The articles belonging to the gun carriage are, an elevating screw, two axletree boxes (" right or near" and "left or off"), side arms (two traversing handspikes and two sponges, one of each being spare), a leather pricker pocket, a leather pocket to receive a tube pocket, and a drag shoe with chain.

The elevating screw, which is known as the Whitworth pattern, Plate VIII., is attached to the gun in the usual way by a bolt and is worked by a metal nut through which it passes. Bevel teeth are cut upon the lower part of the nut, into which a bevel wheel upon a horizontal spindle gears. The nut and bevel wheel are contained in a wrought-iron box, having a trunnion upon each side by which it is supported and can oscillate between the brackets. The lid of the box is secured to the bottom by four long screws and has a lubricating hole in it for oiling the bevel wheels through, which hole is filled by a metal screw to keep dust and grit out; a drip hole is made in the bottom and the interior is coated with red lead. The spindle of the bevel wheel passes through a metal bearing or bouch in the right trunnion of the box and upon its extremity outside the right bracket of the carriage has a metal hand wheel by which it is worked. To remove the box from the carriage the lid has to be taken off, the pin holding the spindle pulled out, and the spindle withdrawn. The second transom of the carriage has then to be removed, after which the bolts of the sockets being taken out, the box with the sockets can be moved to the front and the former freed from the latter.

The axletree boxes are made of yellow deal with ends of elm and internal fittings of mahogany. Each is arranged to carry two rounds of case and small stores. The lid serves as a seat when required, it is covered with canvass, bound with copper and fastened by a spring lock and by a hasp with turn-buckle. The box is strengthened by corner squares of iron and bound with an iron band in which there are sockets for the standards of a guard iron for the protection of a man when

seated on the lid : for his feet to rest upon there is an iron step, the side pieces of which slide in staples upon the sides of the box, so that, when not required, the step can be pushed up against the front of the box and there retained by a turn-buckle for the purpose. The boxes of gun carriages issued to R.H.A. are not fitted with steps and guard irons as they are not required as seats. For attachment to the axletree bed each box has underneath, at one side two nib irons, and at the other two nibs through which double nutted securing screws pass. The boxes are fitted with blanket straps, and the off box has a shell key attached to the back. A leather guard from the dirt of the sponge head is fitted to the near box.

The sponge stave and the traversing handspike are of ash unpainted; the sponge head, of elm covered with fleecy hoisery, is fastened on one end of the sponge stave by a copper wire, and the rammer head, also of elm, bound with copper, on the other end, by a wood pin : in the centre of the rammer head an iron nut is fixed, into which the wadhook worm is screwed for use. The sponge head is protected by a waterproof canvass cover and the rammer head is varnished.

The pricker pocket has a strap and buckle for attaching it to the right bracket, the strap passing round the bracket and the pocket, for carrying the tube pocket, a strap and buckle for attaching it to staples on the inside of the same bracket.

The drag shoe is the field drag shoe, second class, of wrought iron with a steel sole : it has two straps which form a bed for the sole of the wheel. In one of the straps are loops for a strap should the roughness of the ground render it necessary to secure the wheel in the shoe. The chain is of ½″ wrought iron, annealed, and is attached to the shoe by a tongue and slip link. About 4′ from the other extremity of the chain is a second tongue and slip link, and about one foot from the same end a ring; by passing the tongue through the ring and securing it by the slip link, the chain is shortened to the proper length for using the shoe. Supposing the shoe upon the wheel and the carriage in motion, without halting the wheel may be released by simply knocking the slip link off the tongue and so allowing the chain to run to its full length, when the shoe is picked up and hung at the breast of the carriage.

9-pr. M.L.R. Limber. Mark I.

9-pr. M.L.R. limber, Mark I., Plate IX. Construction.

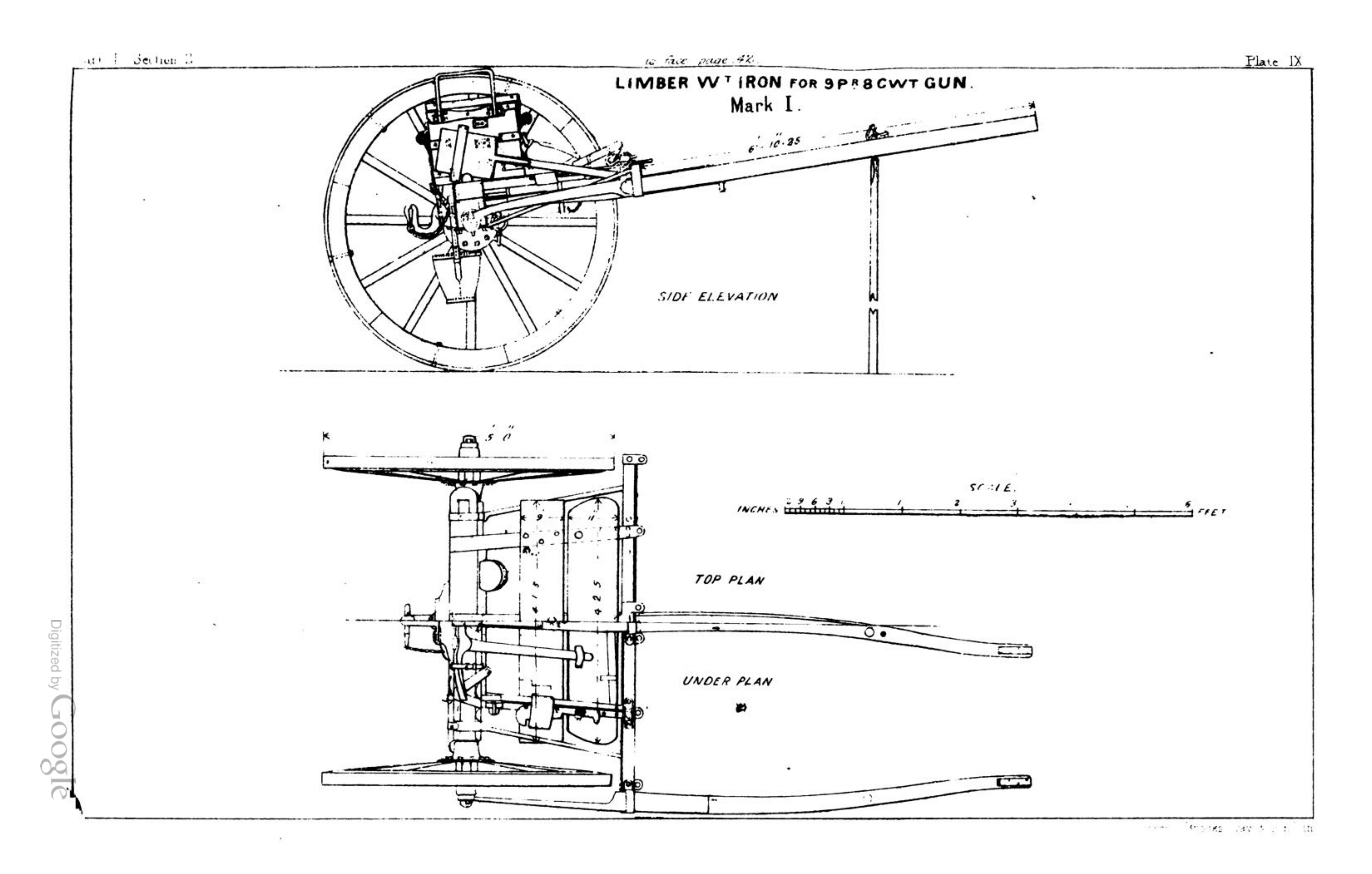
The limber is formed of three futchells, an angle stay, a splinter bar with two stays, a platform board, a footboard, an axletree bed with block and limber hook, an axletree, wheels the same as for the gun carriage, and a pair of shafts.

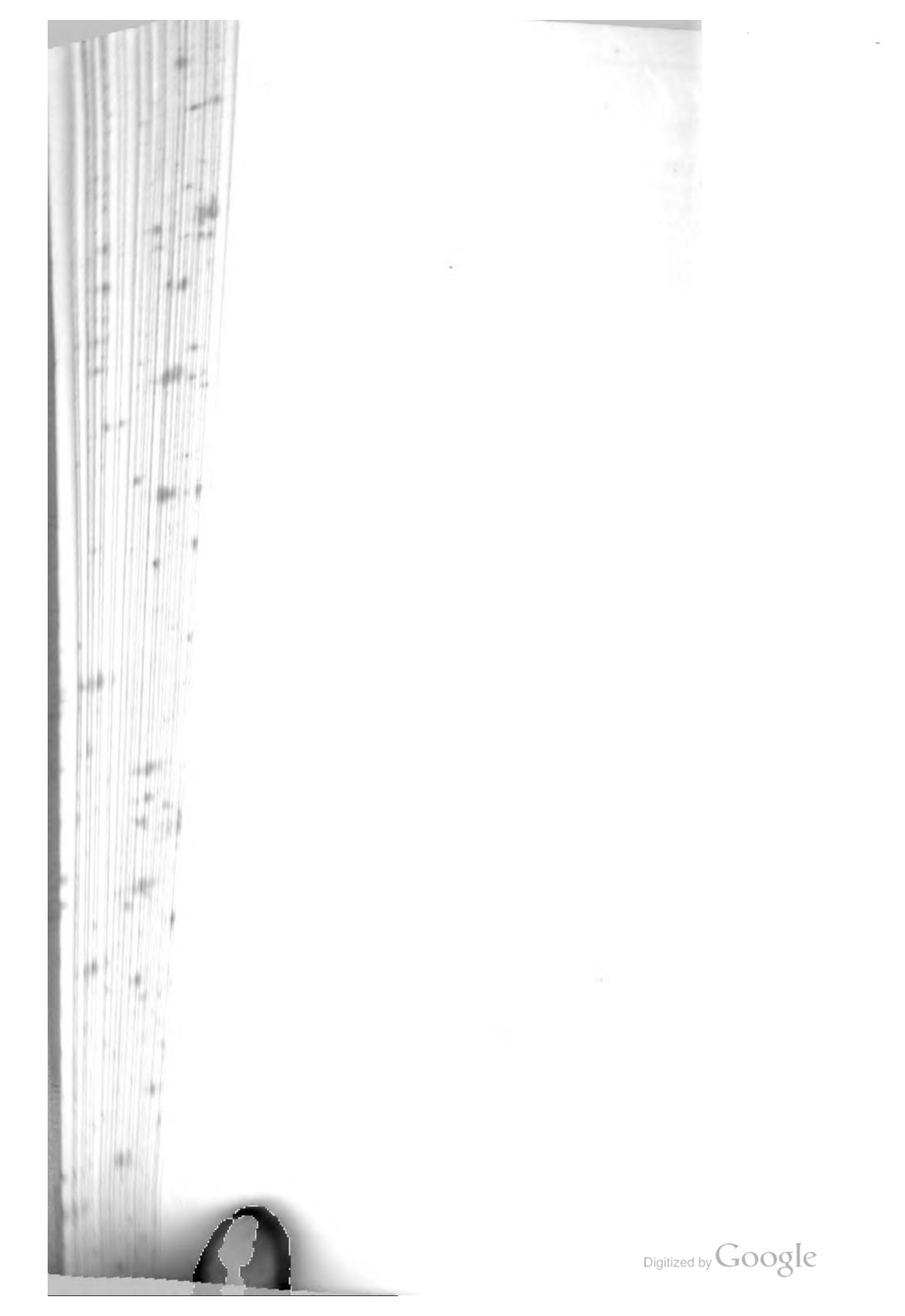
The futchells are of tee iron : the two outer are housed across the axletree bed and secured to it by bolts which pass through V irons (for bullock draught) beneath. The centre futchell is housed in and bolted to the axletree bed in the same manner as the outer futchells, the bolts passing through a clip plate beneath. The end of this futchell is bent down, a knee riveted under it and let into the back of the bed, where it receives the upper bolt of the limber hook, which is screwed into it.

To support the ammunition boxes, in such a position that too much weight may not be thrown upon the shaft horse, four knees of tee iron are secured by screws to the back of the bed.

The angle stay is composed of angle iron with plate iron riveted along its upper surface. This stay is riveted across and under the

to face page 42.





futchells, along the front of the axletree bed, to which it is held by screws. It gives rigidity to the structure, preventing the futchells working across in the bed and retaining the parts in position should it be necessary at any time to remove the bed.

The splinter bar is of plate iron trough shaped. It is bolted to the futchells and strengthened near each extremity by a stay of round iron to the axletree bed: the end of the stay is attached to the yoke band on the bed, forming in fact the coupling plate of the band. The ends of the splinter bar outside the futchells are filled in with wood.

The footboard is of elm, 11″ wide, the platform board of ash or sometimes teak, 13″ wide: they are both bolted across the futchells, the former being raised to the required slope on elm brackets.

The axletree bed is of elm, made in one or sometimes in two pieces. The axletree, which is the light field N.P., is secured in a groove in the bed by yoke bands with coupling plates, and by the V irons and clip plate through which the bolts of the futchells pass.

The block upon which the limber hook rests is of elm and secured to the rear of the axletree bed by screws: the bolts holding the hook pass through the block, the upper one, as before mentioned, is screwed into the centre futchell and the other two also pass through the axletree bed and are nutted in front. The hook is steeled and has a key of steel (marked with the letter "S") which passes through the point for securing the trail eye.

The shafts are the field shafts, "near" and "off:" they are of ash, the off shaft is known as the Brandling pattern, the peculiarity of which is that the part between the splinter bar and axletree arm is of iron (termed the "wheel iron") and consequently much slighter than if of wood, which allows of more room between itself and the wheel for mud to work through. The near shaft is identical with the near shaft of the wood field limber, but the off shaft differs from the off shaft of the latter in the form of the end of the wheel iron.

Fittings for draught.

The limber is fitted for single, double, treble or bullock draught, as follows:—

For single draught the near shaft passes through the near splinter bar band or shaft iron, its extremity entering a "stirrup iron" bolted to the left futchell and being secured by a bolt, which passes from the footboard through it. The off shaft passes through the V-shaped iron, termed the "Brandling iron" upon the splinter bar, where it is supported by a pin, while the wheel iron upon its extremity fits upon an iron crutch upon the axletree bed and is there secured by a linch-pin.

For double draught the off shaft passes through the off splinter bar band and its wheel iron fits upon the axletree arm, serving as a washer, the latter being removed to the crutch. The near shaft passes through the centre splinter bar band, the iron on its extremity entering a socket in the axletree bed: it is secured by the same bolt that held it in single draught, but passed through it from the platform board.

For treble draught the shafts are arranged as for single draught and swingletrees hooked to the trace loops for the traces of the near and off horses.

For bullock draught a pole is fitted through the centre shaft iron, in the same manner as the shaft, and draught chains led from the V irons, beneath the axletree bed to the yoke.

Miscellaneous fittings.

The limber has the following fittings, namely:—For securing the ammunition boxes, there are upon the back of the axletree bed two

large staples with straps for the off and near boxes, and upon a plate riveted to the centre knees a staple with strap for the centre box. Each box is held at the same time by its nib iron entering a box staple in the platform board, where it is retained by a pin. There are also fittings for carrying entrenching tools, grease tin, swingletree, &c., and beneath the axletree bed are jack plates.

Articles belonging to.

The articles belonging to the limber are three ammunition boxes, "near," "off," and "centre," with a canvass cartouch for the near and for the off box.

The near and off boxes, which are similar, are of deal with elm ends, and strengthened with iron clamps : they weigh each when empty 3 qrs. 21 lbs. The centre box is of deal with mahogany ends and weighs empty 24 lbs. The lid of each is covered with canvass, bound with copper, and fastened by a spring lock with stop pin to hold it back when necessary.

The side boxes are arranged to carry the projectiles and cartridges, and are partitioned in such a manner that the former pack on the outer sides of the partition containing the latter, and thus protect them. The projectiles, 18 in each box, stand in trays of beech supported on risers, while their heads fit into blocks on the lid ; the cartridges, 18 in each box, are contained in the canvass cartouch. Beneath the front and rear trays the bottom of the box is hollowed out to admit of four extra projectiles being carried there on emergency. The centre box is divided by copper partitions to contain fuzes and tubes. Each box is fitted with a nib iron and a staple for strap for its attachment to the limber ; the off and near boxes each with a folding guard iron and fittings for carrying entrenching tools, &c., and the centre with a shell key.

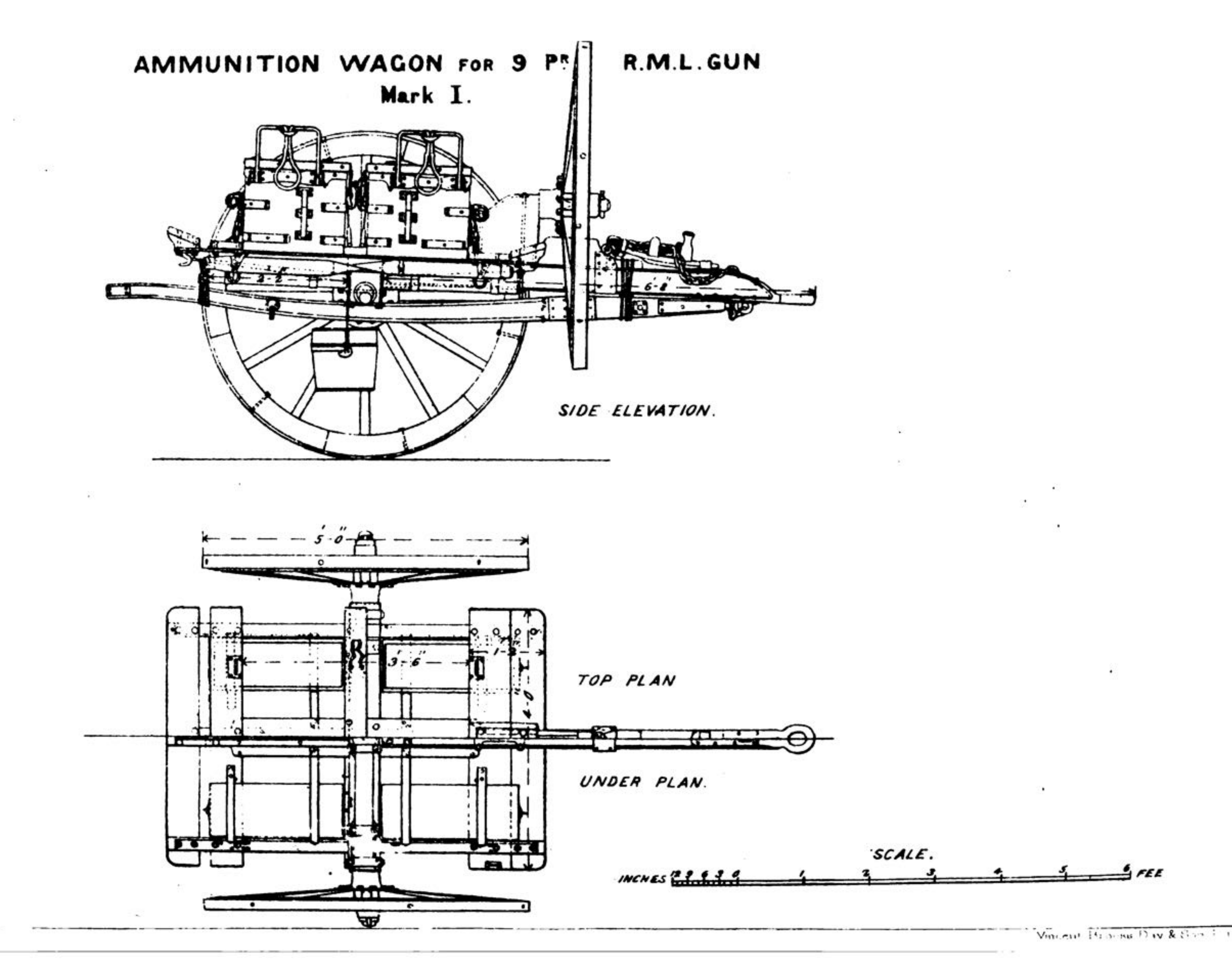
The cartouches for the cartridges are waterproofed and the bottom stiffened with a piece of millboard ; to each is attached a web strap, by which it can be slung on a man's shoulder.

Data respecting the 9-pr. M.L.R. carriage and limber.

The following are some particulars respecting the 9-pr. gun carriage and limber:—

Height from ground of axis of trunnions (unlimbered)	3′ 6″
Horizontal distance of axis of trunnions in front of axis of axletree (unlimbered)	0 1½″
Maximum angle of elevation which can be given to gun	21½°
Maximum angle of depression	4°
Angle which trail makes with ground	22°
Pressure of trail on ground, gun mounted	1 cwt. 3 qrs. 15 lbs.
Horizontal distance of bearing point of trail (unlimbered) from axis of axletree	6′ 5″
Maximum angle through which carriage can lock	52°
Minimum space through which carriage can turn	32′ 3″
Upsetting angle, packed	40¾°
Length of carriage without gun	21′ 0½″
Length of carriage with gun	22′ 4½″
Length between axles	8′ 9¾″
Height from ground to under side of shaft at tug	3′ 6″
" of trace loops (shaft as before)	3′ 4½″
Weight of gun carriage, empty*	†11 cwt. 2 qrs. 9 lbs.
" limber	11 " 0 " 3 "

* Except side arms.
† If for R.H.A., deduct 49 lbs.


AMMUNITION WAGON FOR 9 PR R.M.L. GUN
Mark I.
SIDE ELEVATION.
6' 8"
5' 0"
3' 6"
1' 3"
4' 0"
TOP PLAN
UNDER PLAN.
SCALE.
INCHES
FEE

Weight of gun carriage, packed - -	*20 cwt. 2 qrs. 24 lbs.
,, limber, packed - - -	15 ,, 1 ,, 23 ,,
Weight on wheel horse, packed, men not mounted - - - -	0 ,, 2 ,, 3 ,,
Weight on fore axle, packed, men not mounted - - - -	12 ,, 0 ,, 8 ,,
Weight on hind axle, packed, men not mounted - - - -	15 ,, 1 ,, 12 ,,
Weight on limber hook, packed, men not mounted - - - -	1 ,, 1 ,, 0.

9-pr. M.L.R. Ammunition Wagon. Mark I.

9-pr. M.L.R. ammunition wagon. Mark I. Plate X., construction.

The wagon consists of a perch, two sides, two platform plates, one centre plate, two footboards, three platform boards, an axletree bed, an axletree the same as that of the gun limber, and wheels the same as in the gun carriage or limber.

The perch is of girder iron; at one extremity the web is cut out and the upper tee bent down and welded to the lower, a nose plate with steeled eye clasping both tees and riveted to them; at the other extremity the lower tee is cut away for some distance and the web sloped off.

The sides are of angle iron, that portion which is vertical, when in position on the wagon, being of the fish-belly form.

The platform plates are riveted across the perch and the extremities of the sides; they serve to make the structure rigid and to keep the parts in position when the body is not wooded up.

The centre plate is riveted along the upper surface of the perch.

The footboards of elm and platform boards of ash are bolted across the perch and sides, the first-mentioned being raised to the required slope on elm brackets. The space between the front platform board and front footboard is filled in by a piece of wood 2″ wide added to the platform board.

The axletree bed is of ash or oak; the perch and sides are housed across it and secured to it by bolts from knees riveted on them for the purpose; these bolts pass through the bed and are nutted beneath clips, which latter, together with yoke bands, retain the axletree in the bed.

Fittings.

The wagon has the following fittings:—

For securing ammunition boxes fittings similar to those for the same purpose in the gun limber.

Box irons, &c. for under boxes.

For carrying a spare wheel a sabicu block, with arm to receive the wheel, is bolted over the front platform board and front footboard, and a block of elm, to serve as a stay, is riveted upon the perch. The arm of this sabicu block is strengthened by an iron along the top and by a knee underneath; it has upon it a plain washer which enters the inner flange of the wheel, the latter being secured by another plain washer and by a linch-pin.

The wagon is also fitted with jack plates and locking plates, and for carrying a drag shoe, picket posts, maul, &c.

Articles belonging to.

The articles belonging to the wagon are,—four ammunition and four under boxes, with a canvass cartouch for each of the first named, a drag shoe with chain, and spare lashings.

The ammunition boxes are identical with the off and near boxes of the gun limber, except in some of the leather fittings. The near hind box is interchangeable with the off front box, having the same strapping on

* If for R.H.A., deduct 49 lbs.

D 2

the inside of the lid, and in like manner the off hind with the near front box.

The under boxes are of deal with elm ends, and are each fastened with a hasp and turnbuckle.

9-PR. M.L.R. WAGON LIMBER. MARK I.

9-pr. M.L.R. wagon limber. Mark I.

The wagon limber and its boxes are identical with the gun limber and its boxes. The letter "W" is painted upon the limber and upon the off and near boxes in addition to the number, &c.

Data respecting the ammunition wagon.

Height from ground of upper surface of platform board -	3′ $2\frac{1}{8}$″
Maximum angle through which the carriage can lock -	$54\frac{3}{4}$°
Minimum space through which the carriage can turn -	29′ $8\frac{1}{8}$″
Upsetting angle, packed - - - - -	$35\frac{1}{2}$°
Length of carriage - - - - -	20′ $5\frac{1}{8}$″
Length between axles - - - - -	7′ $7\frac{3}{4}$″
Weight of wagon, empty - -	14 cwt. 0 qrs. 22 lbs.
" limber " - -	11 " 0 " 3 "
" wagon, packed - -	24 " 2 " 8 "
" limber " - -	15 " 3 " 13 "
" on wheel horse, packed, men not mounted - -	0 " 2 " 3 "
Weight on fore axle, packed, men not mounted - - - - -	12 " 2 " 11 "
Weight on hind axle, packed, men not mounted - - - - -	19 " 0 " 11 "
Weight on limber hook, packed, men not mounted - - - - -	1 " 1 " 13 "

9-PR. M.L.R. GUN CARRIAGE. MARK I., FOR INDIA.

9-pr. M.L.R. gun carriage. Mark I., for India.

The 9-pr. gun carriage for India is identical with that for home service, but instead of being fitted for a wooden traversing handspike has an iron tee-shaped handspike bolted on the trail. The handspike pivots on its bolt, so that when not required for use it can be turned over to lie along the trail; when in position for traversing a movable pawl upon it catches in a stop upon the trail, and secures the handspike until the pawl is raised.

The carriage does not carry a drag shoe but the wheel is locked, when necessary, by the chain, which is passed round the felloe and a tongue at its extremity secured by a slip ring in a ring for the purpose on the chain itself.

9-PR. M.L.R. LIMBER. MARK I., FOR INDIA.

9-pr. M.L.R. limber. Mark I., for India.

The limber for service in India differs from that for home service in being fitted to carry a 5′ common handspike under the front of the foot-board, and in having different ammunition boxes. The off and near boxes have fixed loop guard irons, one at each side of each box, instead of a folding guard iron at one side only; they have also a plain staple instead of a handle on the back and front. The loop guard irons are for the purpose of passing a bamboo through, and so carrying the box slung from men's shoulders.

9-PR. M.L.R. AMMUNITION WAGON. MARK I., FOR INDIA.

9-pr. M.L.R. ammunition wagon. Mark I., for India.

The ammunition wagon is the same as the wagon for home service but is fitted with only one under box, and carries a drag chain without shoe. Its boxes are similar to the off and near boxes just described for

the limber. The wagon limber is the same as that for the gun carriage.

Forge Wagon and Field Forge. Mark I., for India.

The forge wagon for Indian service is the same as the ammunition wagon, except that the footboards are laid flat upon the frame with an extra board in front, supported at each side upon a projecting piece of angle iron secured to the footboard.

Forge wagon. Mark I., for India.

The anvil rests in a shoe upon the centre of the extra board and front board, the anvil block at the off side of the anvil and the vice box upon the near. A nail anvil is fixed upon the perch. On the near side of the wagon underneath in front there is an iron box for horse-shoes and nails, and in rear a wooden box for grease tins. There are no fittings for carrying a spare wheel.

A canvass cover but no bale hoops are issued with the wagon.

The wagon limber is the same as the gun limber, but carries only one long box.

Field forge.

The field forge is the same as the wrought-iron forge for home service to be hereafter described, except that it has side plates riveted over the sides of the frame and supported by knees, and also that the frame has two handles instead of four.

When the forge is on the wagon each side plate serves to support a wooden box which carries horse-shoes. The frame is secured on the wagon in front by nib irons, and in rear by straps passed through the handles. The water trough is hung upon the fender of the hearth, and is secured by a strap. Six bushels of charcoal are carried in a sack upon the top of each side box.

9-pr. M.L.R. Gun Carriage. Mark II.

9-pr. M.L.R. gun carriage. Mark II.

The main points of difference between this and Mark I. carriage are as follows:—

The construction of the brackets, in which the plate is placed on the

Fig. 1.

Section.

Elevation.

inner instead of the outer side of the bracket frame, and the form and manner of connexion of the trail plate.

The brackets are housed over, (see *Fig.* 1,) and riveted through their frames to the axletree bed; they are also secured to it by the front transom which is riveted to them and to the bed, and further by a small bracket stay between each bracket and the back of the bed.

Placing the plate upon the inner instead of the outer side of the bracket frame gives greater strength to the bracket by bringing the plate more under the trunnion, or as it may shortly be expressed "nearer to its work." This mode of construction has also the advantage of being the more convenient for manufacture.

The transoms are of plate iron; the front transom has a frame of angle iron riveted to it in front; the second transom has a piece of angle iron riveted along each side in rear.

The trail piece is formed, not as in Mark I. carriage, to lap under and over the point of the trail, but to lie partially between the bracket sides; this form has been adopted as giving a stronger neck to the trail eye, and being much easier of manufacture. A bearing plate of steel is bolted beneath the point of the trail.

The axletree boxes are attached to the top plate of the axletree bed by nib irons on the inner side and screws on the outer, as in Mark I. carriage.

The wheels are the same as in Mark I. carriage.

The elevating screw box is secured in its sockets on the brackets by capsquares with double nuts, which makes it much more convenient for removal when required.

The other fittings and the articles belonging to the carriage are similar to those of Mark I. carriage; the axletree boxes are not interchangeable with those of the latter carriage on account of the different width of the top plate of the axletree bed.

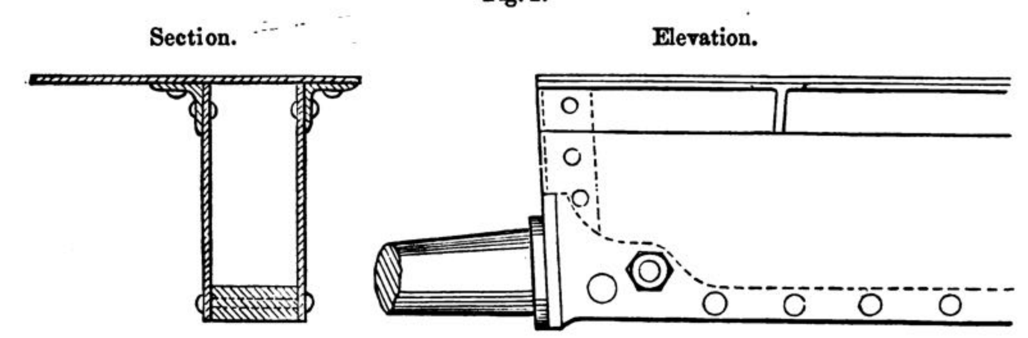
9-pr. M.L.R. Limber. Mark II.

9-pr. M.L.R. limber. Mark II.

This limber differs from Mark I. in having a wrought iron instead of a wooden axletree bed, and no block between the latter and the limber hook.

The axletree bed, *Fig.* 2, is formed in a similar manner to that of the gun carriage, but being of necessity deeper than the latter, its sides

Fig. 2.



are constructed of plate iron, a piece of angle iron being riveted along each for the top plate to rest upon and to be secured to.

The futchells are let into the bed beneath the top plate and riveted to its angle iron ; the centre futchell is bent and its end riveted to the back plate of the bed, while the outer futchells project to the rear for the support of the top plate under the limber boxes ; the latter plate is also strengthened by a stay near each end.

The limber hook is forged with three long arms, by which it is riveted to and at the same time held at a sufficient distance from the rear of the bed : the rivets holding the upper arms have collars on them.

The platform and footboards are both 10″ wide, and beneath the front of the latter a slat is secured across the futchells to prevent a horse getting his leg between the splinter bar and the board.

The wheels are the same as in Mark I. limber.

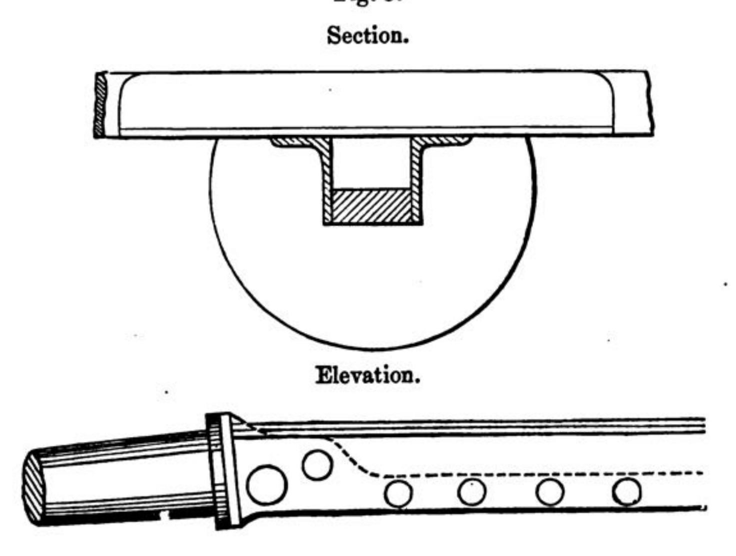
The fittings and articles belonging to the limber are the same as in Mark I.

9-pr. M.L.R. Ammunition Wagon. Mark II.

9-pr. M.L.R. ammunition wagon. Mark II.

This wagon differs very considerably from Mark I. Its axletree bed, *Fig.* 3, is of wrought iron, built up in the same manner as that of

Fig. 3.

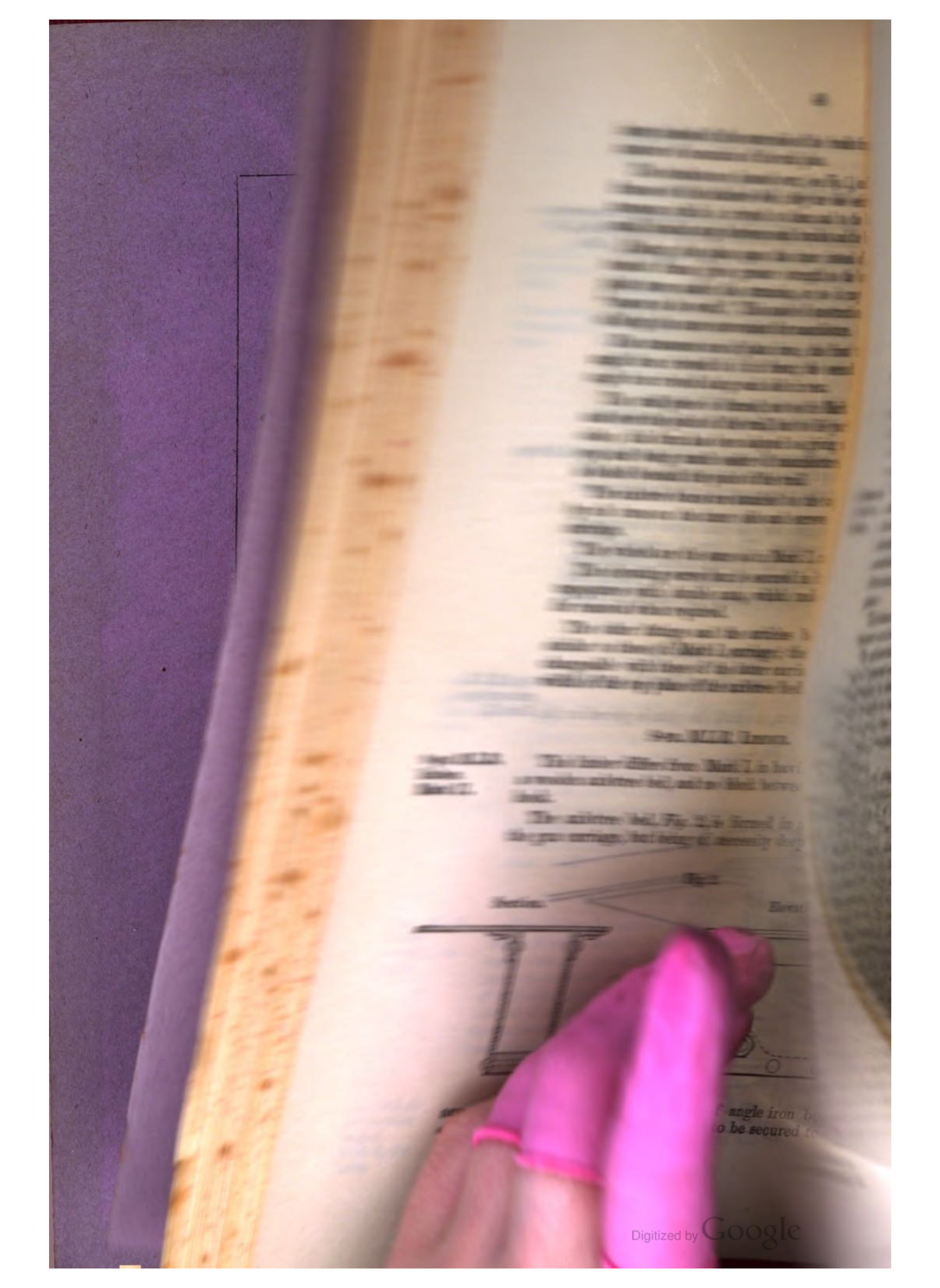


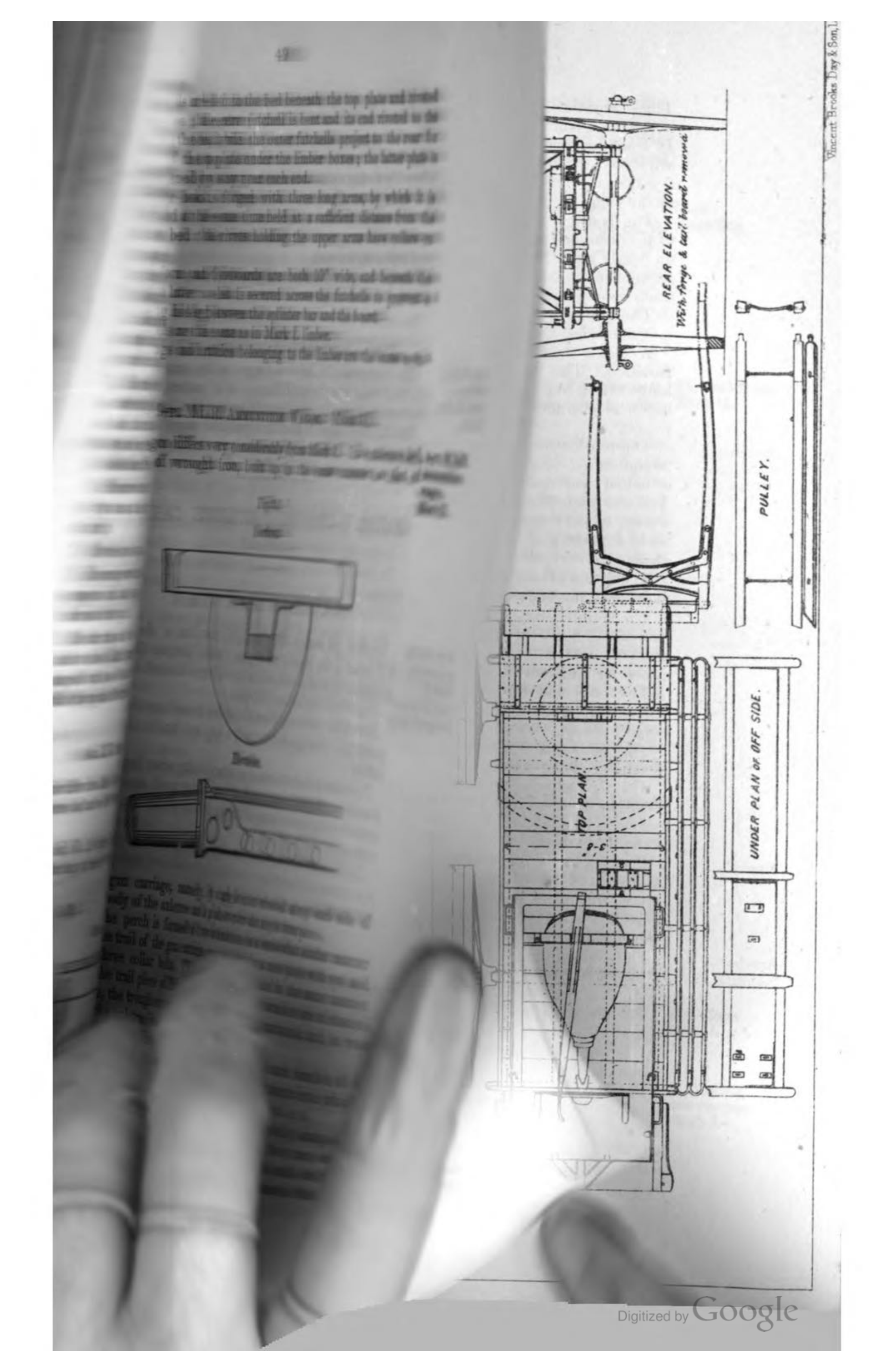
the gun carriage, namely, by angle iron riveted along each side of the body of the axletree and a plate over the angle iron pieces.

The perch is formed of two brackets in a somewhat similar manner to the trail of the gun carriage, connected by a nose piece with eye and by three collar bolts. The nose piece is formed in the same manner as the trail piece of Mark II. gun carriage. The brackets are of channel iron, the trough or channel in each being turned outwards, and, in rear of the axletree bed, the lower part sloped off.

The perch lies across the top plate of the bed, each bracket of the former being connected to the latter by a piece of angle iron which is riveted to both as well as by rivets through the channel iron.

The sides of the wagon are of angle iron, fish-belly shaped, as in Mark I. wagon; they rest upon the bed to which they are each connected by angle iron. To the outside of each side and to the bed is also riveted a stay of plate iron, which much increases the rigidity of the former.




REAR ELEVATION.
PULLEY.
TOP PLAN
UNDER PLAN of OFF SIDE.
Vincent Brooks Day & Son, L

A platform plate is riveted across the perch and sides beneath the front and rear platform boards, which latter are as in Mark I. wagon.

The wheels are the same as in Mark I. wagon.

The block for the axletree arm upon which the spare wheel is carried is formed by riveting a plate to the inside of each bracket and standing up from the latter. The plates are connected by two collar bolts and have the arm, which is of wrought iron, solid, riveted between their upper extremities; upon the perch extending under the footboard the usual wooden stay is riveted.

The other fittings and articles belonging to the wagon are the same as in Mark I.

9-pr. M.L.R. Gun Carriage, &c. Mark II. for India.

9-pr. M.L.R. carriages. Mark II. for India.

This carriage with its limber and wagon are the same as Mark II. for home service, with the usual difference in the pattern for India of the traversing handspike, guard irons of the ammunition boxes, &c.

Mark II. forge wagon is Mark II. ammunition wagon fitted for a forge.

CHAPTER V.—IRON FIELD ARTILLERY CARRIAGES —*continued.*

16-pr. M.L.R. Gun Carriage. Mark I.

16-pr. M.L.R. gun carriage. Mark I. (R.C.D. photo-lithograph, 9b.)

The 16-pr. gun carriage differs but slightly from that of the 9-pr., it is 1″ deeper in the brackets and of greater width between them, also stronger at the trunnion holes, and the latter of larger dimensions.

The carriage takes the heavy field wheel.

Between the brackets a trail box of sheet iron divided into two compartments, is fitted; its lid is secured by a hasp and turnbuckle with padlock.

The sockets to receive the trunnions of the elevating screw box differ from those in the 9-pr. carriage, Mark I., in having small capsquares secured by bolts, so as to admit of the easy removal of the box when required.

The fittings for carrying stores are slightly different to those of the 9-pr. carriage, and the axletree boxes have copper instead of mahogany partitions.

16-pr. M.L.R. Limber. Mark I.

16-pr. M.L.R. limber.

The limber for the 16-pr. gun carriage, Mark I., is the same as for the 9-pr. carriage, Mark I., except that it has heavy instead of light field wheels, in order that they may be the same as on the gun carriage.

The limber boxes differ from those of the 9-pr. only in the internal fittings; the weight empty of the off or near box is 3 qrs. 19 lbs., and of the centre 22 lbs. The off and near boxes carry each 12 rounds of ammunition; their front and hind trays for the projectiles are made in two parts, and all the trays are strengthened by angle iron along the lower edges. Extra projectiles cannot be carried beneath the trays.

Data respecting the carriage and limber.

Height from ground of axis of trunnions (unlimbered) -	3′ 7½″
Horizontal distance of axis of trunnions to the front of the axis of the axletree (unlimbered) - - -	0′ 1½″



Maximum angle of elevation which can be given to the gun	$22\frac{1}{2}°$
Maximum angle of depression which can be given to the gun	$12\frac{1}{4}°$
Angle which the trail makes with the ground	22°
Pressure of the trail on the ground, gun mounted	2 cwt. 1 qr. 14 lbs.
Horizontal distance of axis of axletree from bearing point of trail (unlimbered)	6′ 5″
Maximum angle through which the carriage can lock	0′ 51″
Minimum space through which the carriage can turn	32′ 4″
Upsetting angle, packed	—
Length of carriage, without gun	21′ $0\frac{1}{2}$″
" " with gun	22′ 10″
Length between axles	8′ $9\frac{3}{4}$″
Weight of gun carriage, empty*	13 cwt. 0 qrs. 23 lbs.
" limber "	11 " 1 " 9 "
" gun carriage packed	26 " 1 " 17 "
" limber "	16 " 0 " 15 "
Weight, packed, on wheel horse (men not mounted)	0 " 2 " 10 "
Weight, packed, on fore axle (men not mounted)	12 " 1 " 16 "
Weight, packed, on hind axle (men not mounted)	20 " 2 " 14 "
Weight, packed, on limber hook (men not mounted)	1 " 1 " 7 "

16-pr. M.L.R. Ammunition Wagon. Mark I.

16-pr. M.L.R. ammunition wagon. Mark I.

The ammunition wagon is the same as the 9-pr., but having heavy instead of light wheels. Its boxes are the same as those of the gun limber, except in the leather fittings.

The wagon limber is the same as the gun limber.

Weight of wagon, packed	25 cwt. 1 qr. 4 lbs.
" " limber "	16 " 1 " 7 "
Weight, packed, on wheel horse, men not mounted	0 " 2 " 10 "
Weight, packed, on fore axle, men not mounted	12 " 3 " 26 "
Weight, packed, on hind axle, men not mounted	19 " 0 " 11 "
Weight, packed, on limber hook, men not mounted	1 " 2 " 25 "

16-pr. M.L.R. Gun Carriage and Ammunition Wagon. Mark II.

16-pr. M.L.R. gun carriage and ammunition wagon. Mark II.

Mark II. gun carriage for the 16-pr. is similar to Mark II. for the 9-pr., but having heavy wheels; with the same exception, and the internal fittings of the boxes, the limber and ammunition wagon are identical with those of the 9-pr.

Royal Artillery Wagon. Mark I.

R.A. wagon. Mark I. †Plate XIV. Construction of the body.

The body of this wagon consists of a framework formed by two "sides" and two "summers" mortised into a front and rear "earbed."

* Except side arms.

† The forge is now carried altogether within the wagon, instead of as shewn in the Plate, the tailboard of the wagon being up.

This framework is strengthened by plates riveted on the inside: it is housed and bolted to a front "bolster," a "cross bar," and a rear bolster. In front and rear of the front bolster a front and rear "wheel bolster" are bolted to the summers, and to these three the upper "wheel plate' is attached. The front bolster is shod with a friction plate and is plated at the sides.

The body is supported over the hind axle upon two "side stays" of tee iron, and a "cross stay" of round iron. Each side stay rests in an "axle block" of oak upon the shoulder of the axletree, where it is secured by "axletree staples," by a "clip plate," and by the end of the cross stay, which latter serves as a "coupling plate."

The frame is boarded over to form the bottom of the wagon and movable sides, head and tail board are fitted to it.

A locker is formed in the front of the wagon body by a sliding partition. The lid of the locker serves as a seat, a back board being hinged to it, and a footboard to the headboard of the wagon. A small locker is also formed between the summers underneath the rear of the wagon.

Construction of the fore carriage.

The fore carriage of the wagon is formed of four "futchells" housed in and bolted to a "splinter bar" and a "cross bar." An upper bolster is bolted over and an under bolster beneath the centre of the futchells. A wheel plate is attached to the upper bolster, to the cross bar, and to a small wheel bolster placed in front. The upper bolster is shod with a friction plate, and both it and the lower bolster are strengthened by plates.

The frame of the fore carriage is supported over its axle in the same manner as the body over the hind axle.

The splinter bar is fitted with links to take trace hooks, and with a pair of "general service frame shafts, with double bar," attached in the usual manner to shaft eyes by a pin and key. They can be placed either for single or double draught.

The body and fore carriage are connected by a "main pin," which passes through "bolster plates" in the main bolsters, and is nutted and keyed beneath.

The footboard is of elm, the other boarding of yellow deal, and the remainder of the woodwork of the wagon of oak.

The fore wheels are 3′ 4″ in diameter, the hind 5′ 0″, the latter being the light field wheels. The axles are consequently second class; the fore axle is slightly longer than the hind, in order to make the track of the fore wheels the same as that of the hind.

Fittings.

The wagon is fitted to carry a spare fore wheel, entrenching tools, carbines and swords, stores, and a drag shoe with chain; it has also certain fittings to enable it to be used as a forge wagon when required. A friction plate is attached beneath the frame to prevent the fore wheel injuring it in wheeling on rough ground.

Articles belonging to.

The following articles belong to the wagon, namely, two "floating raves," five "bale hoops," a waterproof "canvass cover," with lashing rope, "bar stay," and, to secure the spare wheel, three "lashing ropes."

The floating raves are each formed of three slight bars of ash, placed parallel to each other and connected by irons at the extremities. Each rave is fitted with four iron brackets for its support on the side of the wagon and has the register number of the wagon painted upon it.

The bale hoops are of ash, fitted with leather stops, and numbered from one upwards, commencing with the front hoop, a corresponding number being placed upon the wagon side at the upper staple for the bale hoop. The front hoop has also the register number of the wagon painted upon it.

To face page 52.

R. A. FORGE WAGON.

Vincent Brooks Day & Son, Lith.

The canvass cover is waterproofed with Abel's composition, and has the register number of the wagon upon it.

The bar stay is a bar of ash to fit from side to side, and keep the sides from spreading out, when the wagon is packed and the tailboard down.

Data respecting.

The wagon is sufficiently strong to take a load of	-	2 tons.
The capacity of the body is 9′ 7″ × 3′ 6″ × 1′ 11¼″	-	=68 1/12 cu. ft.
Minimum space through which it can turn -	-	23′ 7″
Maximum angle through which it can lock -	-	103°
Upsetting angle, packed - - -	-	28½°
Length between axles - - - -	-	6′ 0″
Length from splinter bar to tail board - -	-	11′ 3½″

The Field Forge. Mark II.

The field forge. Mark II.

The field forge is formed of a rectangular "frame" of angle iron, supported, when in use, upon four legs also of angle iron, which, when the forge is placed in the wagon, fold beneath the frame.

The "hearth" is of plate iron supported over one end of the frame on collar bolts, it is fitted with a "fender" and with a "back." The fender is simply a narrow piece of plate iron secured by screws round the front of the hearth, the back is also of plate iron, semicircular in form and hinged to the hearth, so that it can fold down upon the latter or stand erect when it is kept in position by keys. The back is protected from the fire by a "back plate" of cast iron, and has at the reverse side a "nozzle plate" to receive the nozzle of the bellows, from which the blast passes to the hearth, through a hole for the purpose in the back and the back plate.

At the further extremity of the frame from the hearth a "rocking staff frame" is hinged for the support of the bellows and rocking staff, the former resting in slots in the sides of the frame, and the latter pivoting on a tee swivel upon the top. An **S** hook connects the rocking staff to the bellows for use.

The forge frame is fitted with four handles; when placed in the wagon it is secured by two screws, one at each side, passing through an eye in the frame into a hole in the bottom of the wagon. Its weight with rock staff, **S** hook, and stays is 2 cwt. 2 qrs. 24½ lbs.

The anvil is of wrought iron faced with blister steel, the anvil block of elm.

The vice, which for use is fixed upon the splinter bar of the wagon, is that known as the "standing vice for the field forge."

The bellows are of elm, with sides of leather, and nozzle of wrought iron, and weigh 2 qrs. 21 lbs.

The water trough is of sheet iron with flat hooks upon the side to hang it upon the outside of the fender for use, and upon the bottom to hang it upon the inside for travelling.

The nail anvil is secured by a nut upon the hind extremity of the near side of the frame of the wagon.

Mark I. forge differs from Mark II. chiefly in being slightly heavier.

Field forge. Mark I.

·45 Gatling Gun Carriage. Mark I.

·45 Gatling gun carriage. Mark I.

In general form the Gatling field gun carriage resembles other iron field gun carriages. (Weight, empty, 5 cwts. 2 qrs. 10 lbs.)

The brackets are formed each of a single plate of iron ·5 thick; they are connected by five collar bolts, two with solid forged shoulders, and two with collars, and by a trail piece.

There is no axletree bed : the axletree is straight on the upper side of the body but curved on the lower, giving a depth of 3½″ at the centre and less at the shoulders, while its width is constant 1·5″ : it is housed into the brackets and secured to each by a clip plate with bolts. A stay of round iron further strengthens the connexion between each bracket and the axletree.

The wheels* are of the Madras pattern, third class, 4′ 8″ in diameter; the washers are drag washers.

The trunnion bearings and capsquares are of metal, each of the latter works in a hinged joint, and is secured by a pin with split key.

The elevating arrangement consists of a small screw of the Whitworth pattern, the hand wheel of which is on the left side.

A tee-shaped iron handspike of the Indian pattern, to fold back upon the trail when not required, is fixed upon the point of the latter, and a trail box of sheet iron, secured by a hasp and turnbuckle, formed between the brackets.

A wooden hinged seat is fixed upon the top of the trail, to the rear of the elevating screw, which folds back so as to allow the handle of the traversing handspike to lie beneath it. A trail handle is riveted at each side of the trail eye.

Upon each side of the axletree a bearing plate is secured by a coupling plate for the support of an axletree box. The boxes are of wood, each to contain one cartridge cylinder, the back and lid covered with bullet-proof Bessemer steel, and the latter fastened by a hasp and turnbuckle for padlock.

·45 Gatling Gun Limber. Mark I.

·45 Gatling gun limber. Mark I.

The limber for the Gatling gun carriage is of similar construction to the 9 and 16-pr. limber, Mark II. (Weight, empty, 7 cwt. 1 qr. 13 lbs.)

The axletree bed is built up of an axletree 2″ wide by 1″ deep, an iron plate on each side of it, and a cast packing piece to complete the top and ends of the box girder; the plates are secured to the axletree and packing piece by through rivets.

The outer futchells are of angle iron, and the centre of tee iron; they are let into the top of the axletree bed, and project to the rear beyond it, for the support of the limber box; a staple for a strap to secure the box is attached to the extremity of each futchell.

The splinter bar is of plate iron, trough shaped, bolted to the ends of the futchells, and supported by a stay near each extremity to the axletree bed.

The platform board is 6″ wide, and the footboard 10″.

The limber hook is of the ordinary form, attached to the bed, without the intervention of a block.

The wheels are the same as those of the gun carriage.

The limber is fitted for single or double draught, with an off and near shaft of the ordinary description for field limbers, but of lighter construction.†

One‡ long box is carried upon the limber to contain eight cartridge cylinders, it is protected by Bessemer steel on the lid and front, in the same manner as the axletree boxes, and the lid is also fastened in the same manner as the lids of the latter boxes. The box is fitted with guard irons of the Indian pattern for slinging on a bamboo, and the

* For service in Africa, with felloes of mahogany and spokes of pedowk.
† For service in Africa, of mahogany.
‡ Two in future, each to take four cylinders.

lid is furnished with a prop to keep it opeu when required, and fitted on the inside to carry a cleaning rod and a split rod.

CHAPTER VI.—EXAMINATION AND REPAIR OF IRON FIELD CARRIAGES.

Wrought-iron carriages being of recent introduction, and the material of which they are constructed being very durable, there has as yet been little experience with regard to their defects and repair.

General defects. As already mentioned under the head of wood carriages, the defects to be looked for in any woodwork are shrinkage, cracks, decay, and worm.

In ironwork, the defects to be expected are wear from friction, as in eyes and hooks, corrosion from rust, and bad fitting where in contact with wood from shrinkage of the latter.

As regards paint, it may be rubbed off or have become perished and blistered from exposure.

Strapping may be perished from age or exposure, or dry and stiff for want of dubbing.

Canvass covering of boxes may be torn, or become open at the binding, loose or rotten.

Adjusting. If carriages require but small repairs, as soon as such are completed, any patches requiring it should be repainted.

Thorough repair. Should carriages want thorough repair and repainting, if the weather is fair it may be done out of doors, but during the operation the carriages should if possible not be allowed to get wet.

For thorough repair, the first thing to be done to a carriage is to strip it, *i.e.*, to remove the boxes and strapping, the next to dismount it.

The wheels and axletree are then examined as already explained, care being taken in removing axletrees from wood beds to mark them so that each axletree may afterwards be replaced in its own bed.

If the trail eye is worn by the limber hook,* the trail plate must be removed by cutting off the heads of the rivets and punching them out, then letting a piece of blister steel in and welding it to the worn part, after which the eye is brought to accurate form, and finally the steel is hardened by raising it to near a welding heat and plunging it into cold water.

Small ironwork taken from a carriage is cleaned by burning off the paint, or, if rusty, by heating it and oiling it while hot, it is then repaired and adjusted to correct form and dimensions. If however such ironwork be much worn or broken, it will be cheaper to replace it by new than to repair it. Very small iron articles should, if broken, always be replaced by new, as in repair they would burn away.

The thread of nuts or bolts is adjusted with the Whitworth taps and dies ; if the thread on a bolt requires to be lengthened, care must be taken to make the die enter its full depth.

The steel sole of a drag shoe, if worn, is readily replaced by a new one ; the eye of the shoe, which is also frequently worn, can be repaired by welding a bit to it.

With regard to side arms, the coating of the sponge head is liable to become loose, or if kept long in store to suffer from moth; in the first

---

* The size of the steeling of trail and perch eyes and of limber hooks is now increased.

case it should be removed and re-glued on, in the second it should be condemned. In no case should the coating be patched or the wool clipped.

In all repairs, surfaces of wood or iron brought into contact should first be coated with white or red lead, or with ordinary paint.

Before leaving the subject of "repairs to a gun carriage," it remains to notice the manner in which a bracket may be repaired if struck by a shot. Should the shot simply pass through the plate iron of the bracket it will not much impair the strength of the latter, but should it cut the angle iron frame the damage will be serious.

In either case, however, the damage may easily be repaired by riveting plate iron over the fracture, first filing down and removing any burrs caused by the shot. The angle iron frame should be mended by two patching plates, one on each side of the bracket, while one will be sufficient to patch a simple hole in the plate of the latter.

To fit a patching plate upon the outer side of a bracket, two or three rivets should be removed adjacent to the fractured part, the plate then laid in its intended position upon the bracket, and the position of the rivet holes marked upon it. These holes should then be drilled, and the plate riveted through them to the bracket, after which, holes for such other rivets as might be considered necessary should be drilled through both plate and bracket, and the former completely riveted on. In placing the rivets, they should be put in from the inside, and headed up on the outside.

If an inner as well as an outer patching plate has to be placed, the former should be laid upon the latter, and the holes in both plates drilled at the same time to ensure their corresponding.

Should the fracture of the bracket frame be near the point of the trail, the inner patching plate should lie over the angle iron and a packing piece should be placed between it and the plate of the bracket.

Repair of a limber.

A damaged splinter bar in a limber may be repaired by patching it in a similar manner to the bracket of the gun carriage, but if much broken is more quickly replaced by a spare bar than repaired.

The block is liable to shrink from the bed, when it must be refitted, and the bolts tightened up.

Repair of a gun carriage.

Small cracks or shakes in a wooden axletree bed do not signify, but if much split or shrunk, the bed should be replaced by a new one. The yoke bands and clips securing the axle should have a bearing against the latter, which, if the bed be somewhat shrunk, may necessitate its under side having to be planed or the axletree packed with painted canvass. The bed is also liable to swell above the upper surfaces of the futchells, and if so must be planed down.

In replacing an axletree care must be taken to put it in "lead" to the front, and to have the points of the arms equidistant from the centre of the limber hook.

The limber hook may require re-steeling, or its key re-straightening.

A shaft broken near the point may be repaired by splicing and riveting on a new end, the iron strapping overlapping the joint, but if broken elsewhere, or if rotten or worm-eaten, it must be condemned. Shafts that are warped may be steamed or put into hot water and then weighted for a couple of days to bring them to their proper shape. If the copper wrapping on the near shaft is torn it must be replaced by new, being packed if necessary to make the shaft fit the iron on the splinter bar properly. The wheel iron of the off shaft, if much worn, can have a fresh end welded to it. With respect to shafts, it is to be noticed that they should ship or unship easily, and at the same time be rigid when in position; they should also be out of wind, and 2′ apart at the points.



Ammumition boxes should have a fair bearing in their seats and fit tightly between the stops securing them; they sometimes require a new board or the clamps to be refitted; the canvass covering may also require renewing, when care must be taken to stretch the new canvass on tight, first white-leading the lid, and to fit the binding tightly down upon it.

Loose staples and screws must be removed and the holes for them plugged up and rebored.

Repair of an ammunition wagon.

The foregoing remarks upon the repair of the gun carriage and limber apply in general to the ammunition wagon as well, and the only point to be spoken of with regard to the latter is the twisting of the perch which sometimes takes place from the strain thrown upon it in going over very broken ground.

A perch of girder iron twisted in this manner may be straightened without removing it from the wagon body, as follows:—It is heated (a field forge will be sufficient for this) along the twisted part, not too highly and as equally as possible, for, if one part be heated more highly than another, in straightening the perch it will bend only at the hottest part. When sufficiently heated a bar of iron is placed in the nose-plate eye and the girder twisted ~~back- till~~ straight, the operation being assisted by pinching it at the same time in the opposite direction with an iron "dog," on both the upper and under tee at the extremity of the deformed part furthest from the nose plate.

Painting after repair.

As soon as the repairs of a carriage are completed it is ready for repainting. Before this is commenced, all blistered and perished paint must be scraped off, and all roughness rubbed down with pumice stone.

Bare parts are first patched over and then the priming coat laid on, when any lump or roughness is again rubbed down. All fissures or cracks are next stopped and then the finishing coat laid on. Great care should be taken in both the priming and finishing coats not to lay the paint on too thick, and to draw it off nicely.

One coat of paint should not be laid on until the previous one is thoroughly dry, which usually takes about 24 hours, and during the painting the carriage ought not to be allowed to get wet. After painting the lettering is done.*

In some cases two coats of patching and one finishing coat is sufficient.

When carriages are repaired in the Royal Carriage Department the letter R. and date of repair is stamped upon each, where the date of manufacture already exists.

Care of Carriages.

Care of carriages.

The points to be attended to with regard to the care of wheels have already been mentioned, the chief being to keep them well greased.

Linch-pins, washers, the end of the wheel iron of the off shaft, and axletree arms should be kept perfectly clean, care being taken in cleaning them not to rub them away too much and so reduce them in size; they can be kept slightly oiled, but if so the old oil must frequently be rubbed off and fresh put on.

All bearings should be kept clean and slightly oiled, and all nuts tightly screwed up.

Ammunition boxes should be removed occasionally and examined underneath.

Drag chains must not be too long or the end of the chain and the eye of the shoe will be worn.

When carriages are not kept under cover, or when they stand under a shed and the shafts are exposed, the latter should not be allowed to rest

* Instructions for lettering, *see* W.O. Cir., 1 January 1874.



upon the ground, but upon the props or upon stones, to keep the points out of the wet. Water should not be allowed to lodge in any recesses of the carriage.

Carriages kept in store should have the bright parts of the ironwork covered with the grease for that purpose.

Defects or damage should be made good without delay, and if the paint becomes rubbed off at any part it should be patched over as soon as possible. Opportunity should be taken of the annual painting to give the carriages of a battery thorough overhauling and repair.

Artificers' tools must be kept clean, and edged tools sharp and ready for use. The latter should never be ground upon a dry stone, as such treatment spoils their temper. Cold chisels after repair should be properly tempered before use.

CHAPTER VII.—MISCELLANEOUS ARTICLES.

Box, range finder. A small wooden box is now approved for carrying the range finder upon the 9 or 16-pr. M.L.R. limber. The lid is canvass covered, secured by a spring lock, and fitted with a leather pocket on the outside. From the bottom of this box nib irons project for its attachment to the foot-board.

Covers for vent slots. Covers for vent slots of B.L.R. guns are made of waterproofed canvass, tacked at the middle part to a hollow wooden case, which is grooved to fit accurately the vent piece of the gun for which it is intended. Each cover has straps and buckles for securing it on the gun, and leather patches to prevent the sights injuring it.

Covers for screw jacks. Covers for screw jacks are of canvass, waterproofed.

Cases for vent pieces. Cases for carrying 40-pr. B.L.R. spare vent pieces upon the limbers are made of strong leather

Drag ropes. Drag ropes are "heavy" and "light;" at one extremity each has an iron hook, painted black, and at the other an eye-splice lined with leather. The light drag rope is of 2″ white rope, and is 15½′ long from the bearing part of the hook to the eye-splice; it is issued to 9 and 12-pr. B.L.R. batteries and to 9-pr. M.L.R. The heavy drag rope is of 3″ white rope 30′ long, and has a slot in its hook to receive a tie attached to the shank. This drag rope is issued with the 20 and 40-pr. B.L.R. and 16-pr. M.L.R. batteries.

Fuze pockets. The fuze pocket is of buff leather, semicircular in shape; the lid is fastened by buttoning upon a brass stud on the front. The pocket will contain five 5-sec. wood time fuzes and a gimlet borer; it has two loops for attachment to a waist strap.

Gun brushes. Gun brushes are used with M.L.R. guns; each consists of an elm head, with Piasaba grass glued into it, fixed upon a stave. The head of the brush is cylindrical, and the total length of the latter, in the case of the 9 and 16-pr., the same length as that of the sponge.*

Lifting jacks. (Plate XV.) There are two descriptions of lifting jacks used in the field, namely, the common or field jack used with the 20-pr. and under, and the common screw or Clerk's jack used with the 40-pr. and siege guns.

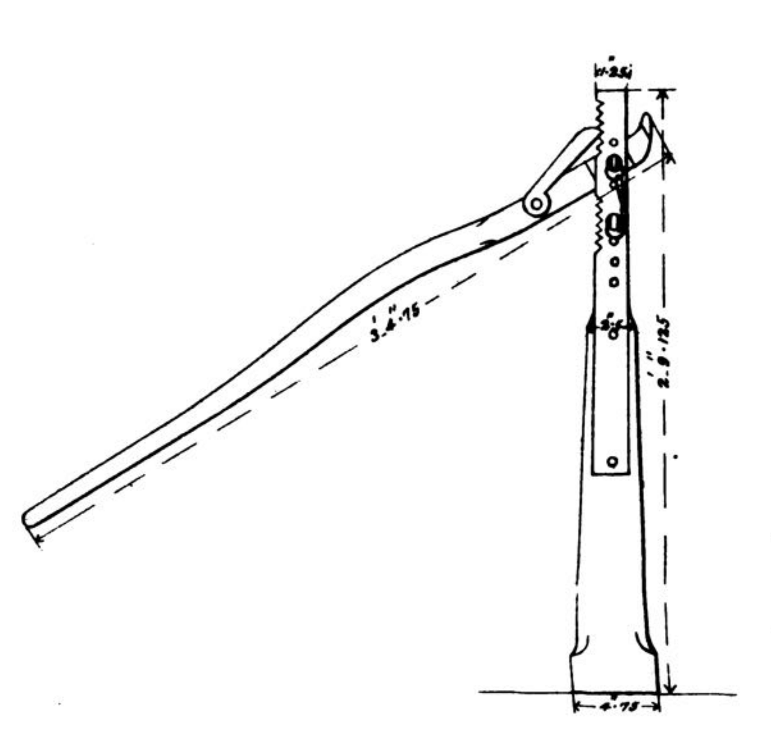
The field jack consists of a pedestal of ash fitted with a forked end of wrought iron. A lever is supported by a pin in the fork, the position

---

* Mark II. differ from Mark I. in being stronger; they have the tufts of grass running spirally instead of longitudinally.

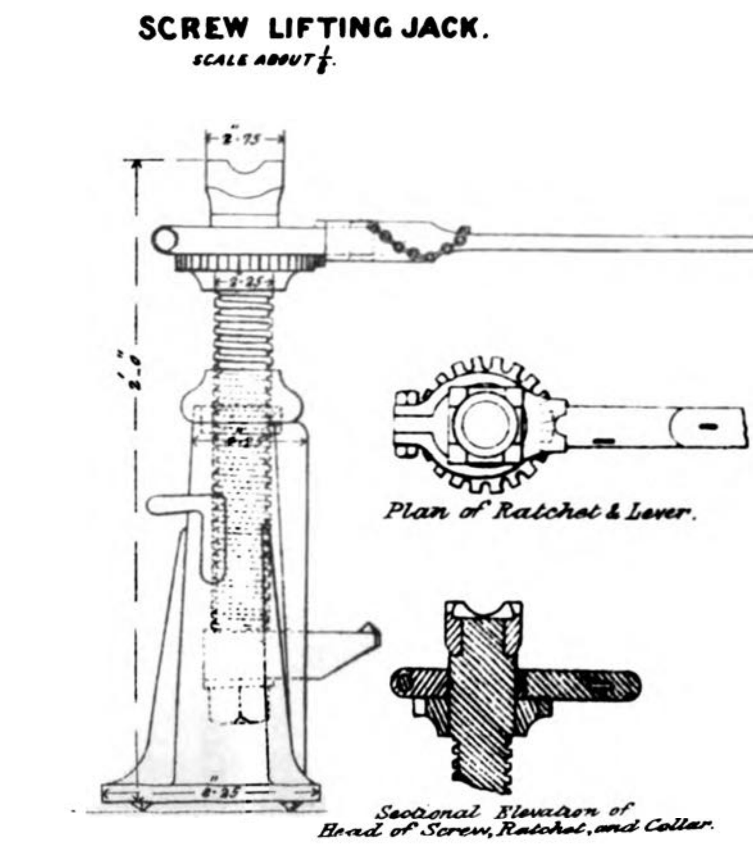
COMMON LIFTING JACK.

SCALE ABOUT 1/13



SCREW LIFTING JACK.

SCALE ABOUT 1/8.



Plan of Ratchet & Lever.

Sectional Elevation of Head of Screw, Ratchet, and Collar.

of which can be varied to suit the heights of the axletree in different carriages. A movable pawl is attached to the lever, which drops into the teeth of a rack upon the back of the fork to keep the lever in position when the weight is upon it. The weight of the jack is 17 lbs., and it is sufficiently strong to lift half a ton.

The common screw jack is similar to the ratchet-headed elevating screw used with the 40-pr. B.L.R. It consists of a screw working in a metal nut fixed upon the top of a cast-iron case or pedestal. The screw is fitted with a ratchet head, a slot in the latter passing over a feather in the former. Above the head a ratchet collar is attached by a bolt to a ring placed round the screw, and secured to it by a pin working in a groove. The ratchet collar, underneath, at the side opposite to that at which it is attached to the ring, has four teeth, and projecting from it, at the same side, an arm over which a lever handle fits. When the lever handle is at right angles to the screw the teeth of the collar gear in the ratchet head, and the screw must then turn with the handle; but when the handle is raised the teeth of the collar rise above the ratchet head, so that, when in this position the handle is turned, it does not affect the screw, and a fresh purchase can be taken. The head of the screw is constructed to take the bearing of the weight; there is also a lifting jaw projecting through a slot in the case, to take the weight if low. The jack has three feet to prevent it slipping, and a handle to lift it by; it weighs 64 lbs., and can lift five tons.

The head should be kept free from grit, and oiled through the hole in it for the purpose.

Mauls.

Mauls are of two kinds, "common" and "iron bound." The first-mentioned is that in general use in the field; the head is of elm, and the handle or helve of ash (identical with that of the pickaxe); it weighs 9 lbs. The head of the iron-bound maul is of hard wood, hooped at each end, the helve the same as that of the common maul; it weighs $11\frac{1}{2}$ lbs. A new iron-bound maul is now approved as Mark II. for garrison or field service: it has the same helve as Mark I., and weighs $11\frac{14}{16}$ lbs.

Picket posts.

Picket posts are of ash, pointed with iron and bound at the other extremity with an iron hoop; below the latter an eye staple is fixed for the reception of the picket ropes or a lashing rope. The picket posts used in the field are $2\frac{1}{2}'$ long, except those carried with the platform wagon, which are 5 ft.

Picket ropes.

Picket ropes are of 3" tarred rope, each 25 yards long.

Spanners.

The spanner used in the field is "McMahon's 15;" it is formed of a bar of iron 15" long, at the extremity of which a claw is fixed, and underneath the latter another movable claw sliding on the bar, which can be set at any required distance from the first by means of a thumbscrew fixed to it at the back and working in a rack formed on the bar.

Sponge buckets.

Sponge buckets are of leather similar to water buckets, but each covered with a teak lid, in which there is a hole, closed by a plug, to admit the sponge. They are only issued with the B.L.R. guns, and are of four sizes, viz., 6-pr., 9 or 12-pr., 20 and 40-pr.

Swingletrees.

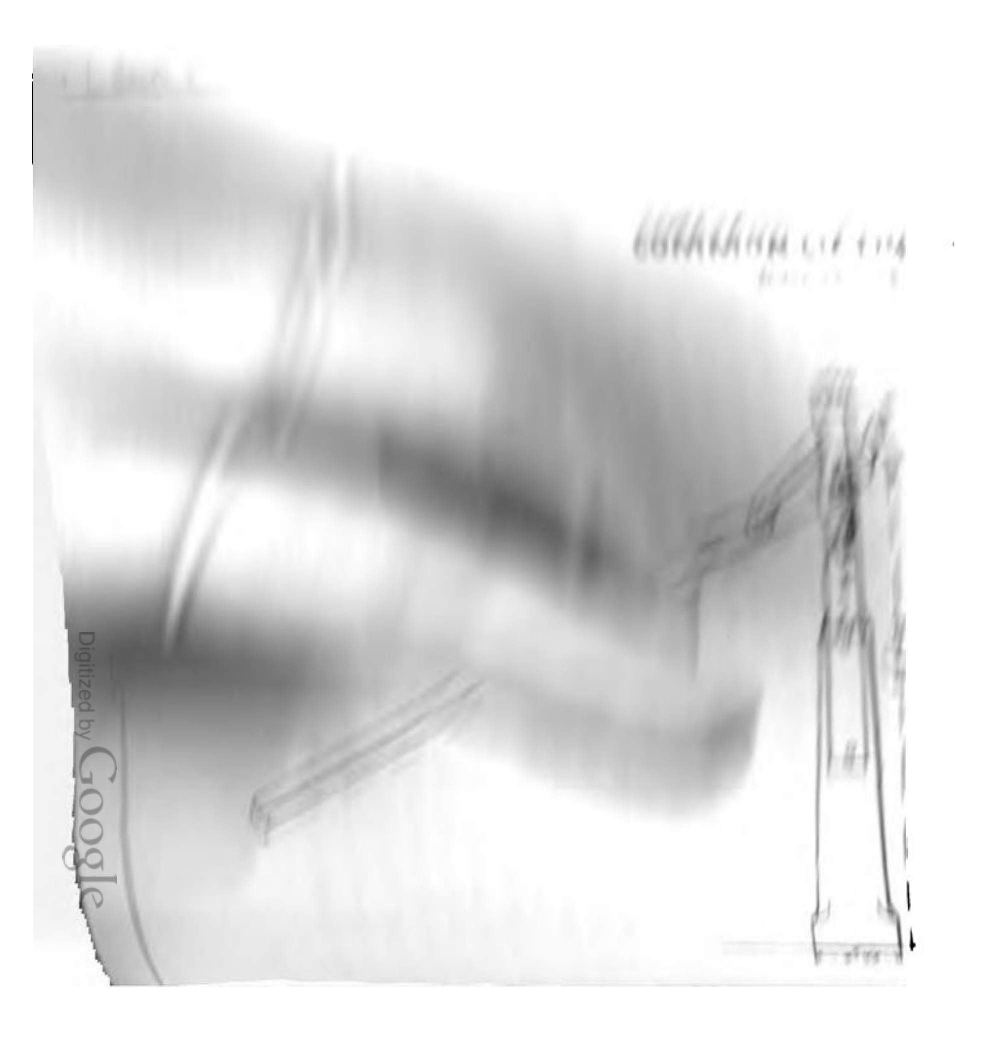
Swingletrees are of ash, having a socket with trace loop at each extremity, and a socket with hook at the centre for attachment to the carriage; they are of three descriptions, viz., No. 1 for siege service, 2' 4" long; No. 2 for field, 2' 4" long; and No. 3 for transport, 2' 0" long.

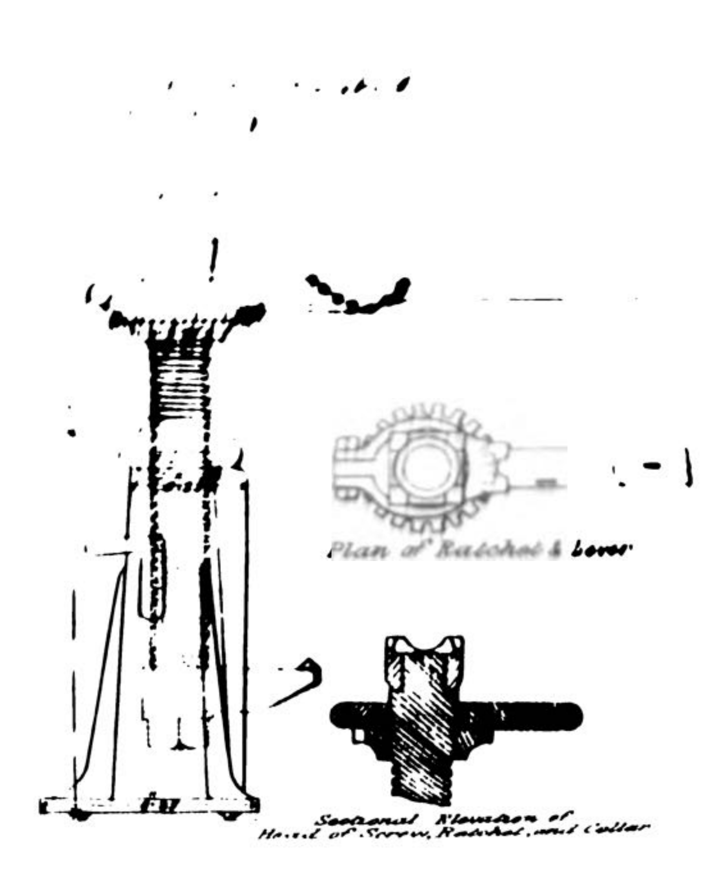
Tampeons.

Tampeons are of elm, the portions which enter the bore being covered with two or three thicknesses of collar cloth glued on.

Ties.

Ties are formed of strips of leather about 5" long. To form a tie one end of a strip is doubled over $\frac{1}{4}$ of an inch, and a bit of stouter leather




Plan of Ratchet & Lever
Sectional Elevation of
Head of Screw, Ratchet, and Collar

which can be [illegible]

riages. A [illegible]

teeth of a rack [illegible]

en the weight is [illegible]

ficiently strong [illegible]

The common screw jack [illegible]

d with the 40-pr. [illegible]

t fixed upon the [illegible]

ed with a ratchet head [illegible]

former. Above the [illegible]

placed round the screw [illegible]

ove. The ratchet [illegible]

ch it is attached [illegible]

same side, an [illegible]

dle is at right [illegible]

het head, and the [illegible]

handle is [illegible]

that, when [illegible]

w, and a fresh [illegible]

structed [illegible]

projecting [illegible]

k has three [illegible]

ghs 64 lbs. [illegible]

The head should [illegible]

t for the purpose.

Mauls are [illegible]

ntioned [illegible]

dle or [illegible]

e. The head [illegible]

h end [illegible]

lbs. A new [illegible]

rison or [illegible]

$\frac{4}{5}$ lbs.

Picket posts are [illegible]

tremity with an [illegible]

reception of the [illegible]

d in the field are [illegible]

gon, which are [illegible]

Picket ropes are [illegible]

The spanner used in the field [illegible]

of iron 13" long, at the [illegible]

d underneath the latter [illegible]

ich can be set at any required [illegible]

umbscrew fixed to it at the [illegible]

bar.

Sponge [illegible]

placed in the double; a hole is then made through the three folds, and the other end of the strip passed through and drawn tight; this forms a button, and a button hole is cut at the other extremity.

Trace couples.

Trace couples are small pieces of round iron, with an eye formed in each end, bent into something the shape of a link until the ends are about ¼″ apart. A trace couple is used to replace temporarily a broken link, the links adjoining the broken one being hooked upon the couple and prevented from coming off by a tie through the eyes of the latter. There are two natures of couples, the heavier for field artillery service of ⅜″ iron, about 6″ long before being bent, and the lighter for transport service of ¼″ iron, about 5″ long before being bent.

SECTION III. — SIEGE ARTILLERY AND MOUNTAIN ARTILLERY CARRIAGES.

CHAPTER I.—WOODEN SIEGE ARTILLERY CARRIAGES.

Table.

The following are the chief wooden carriages for siege service still in existence.

Nature.	Weight, empty.			Tonnage.
	cwt.	qrs.	lbs.	tons.
7″ B.L.R. of 72 cwt. sliding gun carriage - -	14	1	16	1·825
7″ B.L.R. slide - - - - - -	22	0	0	3·375
Transporting limber and siege wheels for 7″ slide -	17	3	4	4·383
64-pr. M.L.R. of 64 cwt. Mark I,.* or B.L.R. of 61 cwt., gun carriage - - - - - -	29	1	6	} 7·35
64-pr. M.L.R. of 64 cwt. Mark I.,* or B.L.R. of 61 cwt. limber - - - - - -	12	0	0	
40-pr. B.L.R. of 35 cwt. gun carriage - -	30	1	0	} 6·18
„ „ limber - - -	12	0	0	
10″ mortar carriage - - - - - -	19	3	24	} 2·14
„ limber - - - - - -	8	2	9	
5⅖″ mortar bed - - - - - -	0	1	0	0·11
General service wagon, O.P., siege - - -	25	1	0	3·77
Platform wagon - - - - - -	22	0	0	3·11
Sling wagon - - - - - - -	18	0	0	3·95
Trench cart - - - - - - -	7	0	0	1·57

* Also Marks II. and III., though they do not fit the carriage accurately.

7″ B.L.R. Gun Carriage, Slide, and Limber.*

7″ B.L.R. gun carriage.

The gun carriage for the 7″ B.L.R. gun is the naval carriage fitted with side plate compressors.

Slide.

The slide is the naval slide raised to a slope of 4° by a front and rear block, and fitted with a siege axletree in the rear block, with a hole for the pintail of a limber in the head, and with draught and keep chains.

* Siege gun carriages have the same track as field gun carriages; viz., 5′ 2″.

For travelling, O.P. siege wheels are placed upon the axletree, and the front of the slide attached to a limber, the same as that used for transporting iron platforms.

Limber.

In battery the slide is unlimbered, the wheels removed, and the slide placed upon a platform, to which it is pivoted by a fighting bolt in front.

64-pr. M.L.R. or B.L.R. Gun Carriage and Limber.

64-pr. M.L.R. or B.L.R. gun carriage and limber.

The gun carriage and limber for the 64-pr. are similar to those for the 40-pr. to be presently described; the gun carriage is converted from the 8″ S.B. carriage, and has no traversing arrangement. The nut of the elevating screw is elongated, and the hole for the screw in it nearer one extremity than the other, by which means the distance from the axis of the trunnion holes to the elevating screw can be varied to suit either the M.L. or B.L. gun: for the latter, the nut is placed in the pan on the trail with the hole in it to the rear, and for the former with the hole to the front.

40-pr. B.L.R. Gun Carriage and Limber.

40-pr. B.L.R. gun carriage.

The 40-pr. gun carriage has the O.P. siege axletree and siege wheels: it is fitted with a traversing arrangement similar to that of the 20-pr., and has two sets of trunnion holes, "firing" and "travelling." A gun roller of sabicu, 14″ long, is used for shifting the gun upon from one set of trunnion holes to the other, which when not in use is slung by a grummet upon a hook on the breast of the trail. To prevent the gun injuring the traversing screw in being shifted, a cleat is fixed across the trail to the rear of the elevating screw. In travelling the elevating screw and its handle are carried in leather pockets for the purpose on the right of the carriage, and the gun is secured by breech and muzzle straps.

The carriage is not fitted for a traversing handspike, but carries instead five common handspikes; it has four trail handles and no axletree boxes.

The elevating screw is the "ratchet head and lever," "Smith's," attached neither to the gun nor to the carriage. The head of the screw is the same as the head of the screw jack already described. The nut for the screw is square and rests in a metal socket or pan in the trail. The drag shoe is the first class siege drag shoe with ¾″ chain; the rammer and the sponge are separate, and the head of the former in one piece with the stave.

The first carriages used for the 40-pr. were converted from the 24-pr. S.B. carriages, and were not fitted with a traversing arrangement.

40-pr. B.L.R. limber; "siege limber."

The 40-pr. limber takes the heavy field wheel, and differs from the 12-pr. B.L.R. or field limber, chiefly in having a straight pintail with keep chain instead of a limber hook with key, and in being fitted for four-horse draught. This is arranged by an "off" and "near siege" shaft, the latter the same as the field shaft, placed in the same manner as for double draught in the field limber, and by a pair of "siege frame" shafts on the near side of the former, together with an outrigger for a swingletree at each extremity of the splinter bar. Each outrigger is strengthened by a stay to the axletree arm, and when not required is folded back upon the splinter bar, and the stay strapped upon the platform board.

When the 40-pr. is issued to volunteers, the shafts of the limber are fitted for farmer's draught, that is, with a back band and with staples for the attachment of the hooks or tees of short traces.

Some 18-pr. S.B. limbers have been converted to 40-pr. simply by altering the internal fittings of the boxes.

*10″ Mortar Carriage and Limber.

10″ mortar carriage. (R.C.D. photo-lithograph, 49.)

The 10″ mortar carriage consists of a bed formed of planks of oak bolted together, the outer ones serving as brackets, with an axletree let into and secured in its under side, and a perch projecting from the rear. A quoin is fitted over the front of the carriage to give the mortar the necessary elevation, and bolts at each side for running up.

For travelling the axletree takes 4′ 2″ wheels (track 4′ 3½″) of the O.P. second class (the same as the trench cart), and the perch is attached to a limber. In battery the carriage is unlimbered, the wheels removed, and the body laid flat upon the ground.

Limber.

The limber is somewhat similar to a trench cart, but fitted with a limber hook, movable shafts (the same as those of the 6-pr. B.L.R. "service" limber), and outriggers for treble draught. Movable battens are fitted in the bottom of the cart to secure the shell in travelling.

5½″ Mortar Bed.

5½″ mortar bed.

The 5½″ mortar bed is a simple rectangular block of oak, hollowed out to receive the mortar and fitted with quoin, capsquares, and rope handles.

Siege Wagon.

Siege wagon.

The siege wagon is the O.P. general service wagon to be hereafter described with the transport wagons, with second instead of third class axles and the same wheels as the trench cart. For the transport of shot and shell, movable trays are placed in the interior.

Platform Wagon.

Platform wagon. (R.C.D. photo-lithograph, 51.)

The platform wagon consists of a fore and hind carriage with a platform fitted over them; it will carry a load of 5 tons.

The hind carriage is formed of an axletree bed and bolster with a perch housed between them, a field axle, and second class O.P. wheels of 5′ 0″ in diameter, 4″ in width of tire, and having a track of 5′ 2″.

The fore carriage consists of an axletree bed and bolster with two futchells housed between them, a splinter bar bolted over the futchells in front, and a sweep bar in rear, an axletree slightly longer than the field axletree, and second class wheels 4′ 0″ in diameter, and 4″ wide in the tire.

The platform consists of a strong oak frame, with side boards attached, which is bolted to the bolster of the hind carriage, and pivots on the bolster of the fore carriage. The main pin which connects the platform with the fore carriage also passes through the perch of the hind.

The splinter bar is fitted with two pairs of siege frame shafts and with outriggers for swingletrees, so that four horses can be harnessed abreast; it is also fitted for a pole for bullock draught.

Upon the sides of the wagon are cleats for carrying either a mortar, mortar bed (10″ mortar and bed, 13″ mortar or bed, or two 8″ mortars and beds), or gun.†

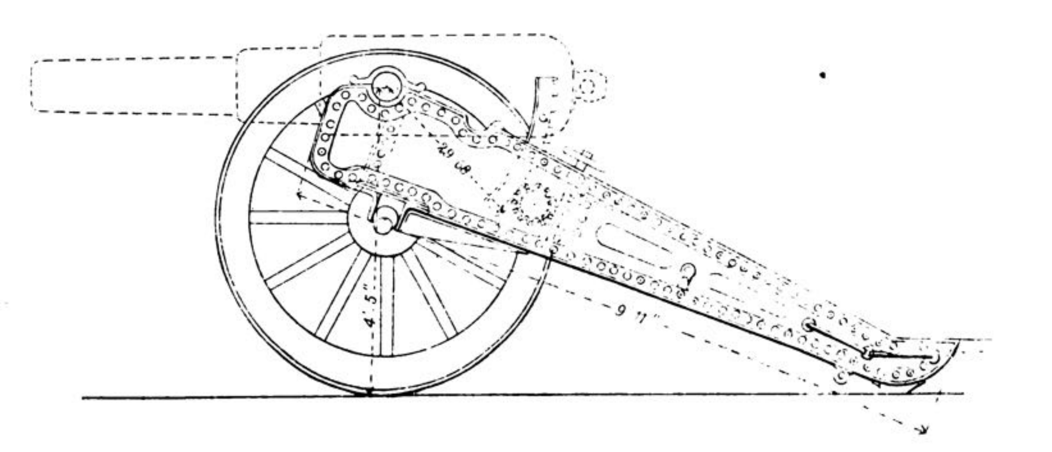
---

* Similar carriages have been made for the 13″ and 8″ mortars, that for the former being fitted with siege wheels and limbering up to the siege limber.

† Issued with a 40-pr. battery of position, the wagon is fitted for carrying a spare siege axletree and wheel, two spare field axles, one spare axle and wheel for the wagon fore carriage, and other stores. And issued with the wagon are seven bale hoops and canvass cover, five swingletrees No. 1, 14 lashing ropes, a wooden tool box, and a drag shoe with chain.

40 P^R W. I. SIEGE TRAVELLING CARRIAGE (MARK I)

SCALE ABOUT $\frac{1}{38}$TH FULL SIZE



Sling Wagon.

See Part II., garrison service.

Sling wagon.

Trench Cart.

Trench cart.

The trench cart is a strong cart capable of carrying a load of one ton, it has a second class axletree with O.P. wheels 4′ 2″ in diameter (having a track of 4′ 3½″), fixed shafts, and movable sides, head and tail board. The frame is of oak and the boarding of elm.

The cart is painted red to distinguish it from the hand cart.

CHAPTER II.—IRON SIEGE ARTILLERY CARRIAGES.

Table.

For future manufacture, iron carriages will take the place of wooden ones, for the siege train, as they have already done for field artillery, as follows :—

Nature.*	Weight.		Tonnage.
	Empty.	Packed.	
			tons.
40-pr. M.L.R. of 34 cwt. gun carriage - -	24 2 0	—	—
„ „ limber - -	11 0 14	—	—
64-pr. M.L.R. of 64 cwt., Marks II. & III. gun carriage - - - - - -	30 2 0	—	—
64-pr. M.L.R. of 64 cwt., Marks II. & III. limber - - - - - -	11 0 14	—	—
8-inch M.L.R. of 46 cwt. howitzer carriage -	42 3 14	—	—
„ „ limber - -	11 0 14	—	—

* The track of these carriages is 5′ 2″.

40-pr. M.L.R. Gun Carriage and Limber. Mark I.

40-pr. M.L.R. gun carriage. Mark I. Plate XIII.

The 40-pr. M.L.R. gun carriage is constructed in the same manner as the 9-pr. M.L.R. carriage, Mark II., that is to say, the brackets have the plate, which is lightened out, on the inner side of the angle iron frame, the axletree bed is of wrought iron, and the trail piece fits between the points of the brackets instead of lapping over them.

The transoms, of which there are two, are each formed of plate riveted to a three-sided frame of angle iron. They are riveted to the brackets, the connexion of the second transom to the latter being strengthened by small bracket stays, while the front transom is riveted to the bed. A bracket stay is also riveted to the front and another to the rear of the axletree bed and to each bracket, in order to unite the bed more firmly to the brackets.

The wheels are the N.P. siege, shod with ring tires ¾″ thick, and not having the flanges of the nave projecting beyond the pipe box.

The trunnion holes are, as in the wooden 40-pr. carriage, firing and travelling, sufficient bearing being obtained for the trunnions by bolting a solid piece to the inside of each bracket; the height of their axis is 4′ 5″.

The gun is elevated or depressed by means of a rack attached to it, which passes between a pinion and a friction wheel upon the inside of the right bracket. The pinion is turned as required by means of a worm wheel and worm shaft with hand wheel, inclosed in an iron

box fitted over them on the outside of the right bracket. 35° elevation and 5° depression can be given to the gun.

The carriage is fitted with two trail handles, an iron box for a spanner, and rests in which to carry the elevating arc when the gun is in the travelling trunnion holes. The fittings for the drag shoe and chain are upon the left of the carriage.

40-pr. M.L.R. limber; siege limber.

The limber* is made entirely of iron, in the same manner as the field limber, Mark II., including the limber hook, but with the axletree further secured by a clip under it near each shoulder.

The wheels are the N.P. heavy field wheels.

The splinter bar is fitted for four-horse draught, in the same manner as the wooden siege limber.

64-pr. M.L.R. Gun Carriage and Limber. Mark I.

64-pr. M.L.R. gun carriage and limber. Mark I.

The carriage designed for the 64-pr. M.L.R. gun is similar to the 40-pr.

The height of the axis of the trunnion holes is 4′ 5″, and the maximum elevation and depression which can be given to the gun is 40° and 10° respectively.†

The limber will be the same as for the 40-pr.

8″ M.L.R. Howitzer Carriage and Limber.

8″ M.L.R. howitzer carriage and limber.

The carriage designed for the 8″ howitzer differs from the two preceding in having brackets of double-plate construction with wrought-iron frames, and in the axletree and its bed, which is formed merely by a piece of angle iron riveted along each side of the axletree, passing through instead of lying beneath the brackets, while a bottom plate is added extending from the rear transom to the breast of the brackets. This construction is rendered necessary as it is intended that the howitzer should be fired from the carriage with the wheels off as well as on.

The lower parts of the brackets are extended to the front to prevent the carriage tipping when the howitzer is fired, the wheels not being on, and the bottom plate is rounded in rear to prevent it injuring the ground platform.

The plates of the brackets are $\frac{5}{16}$″ thick; the rear transom has a forged piece riveted across the top in rear, and both transoms are secured by double angle iron.‡

The elevating gear is worked at the left side; it is similar to that of the 40-pr. and 64-pr. and admits of 40° of elevation being given to the howitzer. When, however, the latter is fired with the wheels on the carriage it is not intended that the elevation should exceed 15° or the charge of powder 5 lbs. The height of the axis of the trunnion holes is 4′ 8½″.

The limber will be the same as for the 40-pr.

---

* Not yet approved.

† A stool bed to act as a shifting plank will be added to this carriage, and to the 40-pr.

‡ It is intended to check the recoil in this carriage by means of a brake.

CHAPTER III.—GROUND PLATFORMS AND MISCELLANEOUS ARTICLES FOR SIEGE SERVICE.

Ground platforms for siege service are as follows :— Table.

Nature.	Weight.			Tonnage.
	cwts.	qrs.	lbs.	tons.
7″ B.L.R. platform - - - - -	16	3	14	1·17
Clerk's „ - - - - -	13	0	0	1·00
Alderson's gun platform - - - -	24	3	0	2·00
„ 13″ mortar platform - - -	22	1	0	1·75
„ 10″ or 8″ mortar platform - - -	10	1	0	0·82

7″ B.L.R. Platform.

7″ B.L.R. platform.

This platform is formed of two oak baulks forming the sides, housed over and secured by iron pins to two oak transoms. The front transom has a hole in it for the pivot bolt of the slide.

In laying the platform the transoms are bedded in the ground.

Clerk's Platform.

Clerk's platform (R.C.D. photo-lithograph, 77).

Clerk's platform consists of two inclined planes, having a slope of 3°, two sleepers, two transoms, and a trail plank.

The inclined planes are fitted each with a riband upon the inner side, and a movable iron stop in front and rear to keep the wheel from running off. Each has a hole at the front extremity for a pivot pin, and at the rear a traversing bolt.

The front transom and trail plank have spikes to secure them in the ground.

To lay the platform the sleepers and transoms are bedded flush with the ground at right angles to the line of fire. The gun, then, being run into position, the wheels are raised in succession, and the inclined planes run under them and pivoted to the front transom. The trail plank is then placed under the trail. In laying the rear transom it must be so placed that in traversing the planes the handspikes can take a bearing upon it.

The platform can be used for a standing or rear chock carriage as well as for a travelling carriage by pivoting the inclined planes sufficiently near to each other. In this case the trail plank is not required, and may be used as a sleeper. With the rear chock carriage the inclined planes are placed with the ribands on the outer sides.

For transport the parts of the platform are lashed together in the form of a rectangular log, the spikes of the trail plank and transom fitting into holes in the inclined planes.

Alderson's Platform.

Alderson's platform, (R.C.D. photo-lithograph, 77.)

Alderson's platform consists of a number of deal baulks of the same size, oak dowels, iron shoes, pins, and screw loops. For a gun platform 58 baulks are required; for a 13″ mortar, 54; and for a 10″ or 8″ mortar, 24.

To lay a gun platform five sleepers are formed by placing for each two baulks end to end, overlapping these by a third, and connecting the three by oak dowels and shoes with screw loops. The sleepers are bedded in the ground at a slope of 3°, parallel to the line of fire. The remaining baulks, connected by oak dowels, are then placed over them, the front and rear baulk being secured by iron pins, and an additional baulk to form a hurter being laid over the front one.

To lay a 13″ mortar platform three sleepers are formed, each of two baulks side by side, and laid level at right angles to the line of fire. Over the sleepers the remaining baulks are laid in two tiers, at right angles to each other, the two outer baulks at each end of the upper tier being pinned to the sleepers.

For a 10″ or 8″ mortar platform six single baulks are laid as sleepers parallel to the line of fire, and the remaining baulks laid across them, the outer ones being pinned to the sleepers.

Miscellaneous Articles.

Miscellaneous articles. Block, dismounting. The dismounting block is of oak, 16″ × 6″ × 5″, with the corners of the upper face bevelled off. It is used in raising a gun out of its trunnion holes.

Covers for vent slots. The covers for the vent slots of the 40-pr. and the 7″ B.L.R. guns are similar to the covers already described for field service, but the latter has an additional strap. The cover for the 64-pr. B.L.R. has no wood block, and is made to cover both the vent and side slots.

Handspike, metal roller. The metal roller handspike is used for traversing the 7″ slide upon its platform ; it is the S.S. handspike without a pawl.

Pocket for tin cups. The leather pocket for tin cups is semicircular in shape, fastened by a strap and buckle, and fitted for a waist strap. It will contain six tin cups for the 7″ or 64-pr. B.L.R.

Rammer, earth. An earth rammer is a cylindrical block of elm fitted with an ash stave as handle.

Skids, dismounting. Dismounting skids are issued in pairs: those for use with the 7″ B.L.R. gun are of fir bevelled at the ends, each 14′ long, by 8″ square, and weighing about 2½ cwt.

The skids for use with the 64 or 40-pr. are of African oak* bevelled at the ends, fitted with grummet handles and with two hooks and loops to connect them for use and hold them 5″ apart. They weigh about 3¼ cwts., and are each 14′ long, by 5½″ square.

Side arms. The side arms for the 40-pr. M.L.R. are as follows :—

Sponge, total length - 8′ 4½″ weight - 6 lbs. head conical.
Rammer, „ - 7′ 11½″ „ - 5½ „
Wadhook, „ - 8′ 4½″ „ - 7 „

And for the 8″ M.L.R. howitzer, as follows :—

Sponge, total length - 5′ 0¾″ weight - 9¼ lbs., head conical.
Rammer, „ - 5′ 3½″ „ - 9 „ head same as for 8″ M.L.R. gun.
Wadhook, „ - 5′ 3½″ „ - 5½ „

Other articles. Other articles, see Part II., Garrison Service.

* It is approved to substitute English oak, strengthening each skid by an iron plate on the inner side; such skids to be Mark II., weight 4 cwts., tonnage ·196.

CHAPTER IV.—MOUNTAIN ARTILLERY CARRIAGES.

The carriages for mountain artillery are as follows :— **Table.**

Nature.	Weight.		Tonnage with Wheels.
	Without Wheels.	With Wheels.	
	lbs.	lbs.	tons.
7-pr. M.L.R. gun carriage for steel gun of 150 lbs. or bronze gun of 200 lbs.	161	287	·402
7-pr. M.L.R. gun carriage for bronze gun of 224 lbs. or steel gun of 200 lbs.	192	*328	·443
7-pr. M.L.R. limber for steel gun of 200 lbs.	—	†333	—
4⅖″ S.B. howitzer carriage (special)	—	344	} ·884
„ limber „	—	358	

* Packed 5 cwt. † Packed 4½ cwt.

Remarks. (R.C.D. photo-lithographs, 1A, 1C, and 1D.)

The first gun carriages for the 7-pr. were constructed of wood; they had O.P. wheels and the "common cross-handled" elevating screw.

The next carriages were for the steel gun of 150 lbs. for service in Abyssinia; they were constructed with steel brackets attached to a wooden transom, and had a steel axletree, O.P. wheels, and the common cross-handled elevating screw.

The present carriages are as follows :—

Carriage for the Steel 7-pr. of 150 lbs., or Bronze 7-pr. of 200 lbs.

7-pr. carriage for steel gun of 150 lbs., or bronze gun of 200 lbs.

This carriage consists of two brackets, a transom, horizontal stay, trail plate, axletree, and wheels.

Each bracket is formed of ¼″ iron plate, recessed to receive the axletree. A piece of angle iron is riveted to the plate round the recess to furnish a bearing for the axletree and a solid bearing at the upper part for the trunnions.

The transom is of plate iron, having a piece of angle iron riveted to it, along each side, for its attachment to the brackets.

The brackets are nearly parallel throughout their length, and are connected by the transom, the stay, and the trail plate, which are riveted to them. Between the points of the brackets a block of sabicu is placed, over which and the ends of the brackets the trail plate laps. The eye of the latter is oblong instead of round, to take a strap or serve as a handle.

The axletree, which belongs to the special class, is secured to the brackets by clip plates. The wheels are Madras pattern, 2′ 6″ in diameter, and have a track of 2′ 3″. The flanges of the naves do not project beyond the pipe boxes.

The carriage is fitted with a stool bed of plate iron (see Plate XIV.), so formed in front as to hook loosely upon a cross-bar between the brackets, while in rear it has two little studs, one at each side, which rest in racks riveted to the brackets. By this arrangement the slope of the bed, and consequently the angle of elevation of the gun, can be very considerably varied. Further, a sliding quoin is attached to the stool bed by clips; this quoin is worked as required by a hand wheel,

which turns a screw passing through a nut formed in the end of the stool bed, and entering a nut in the quoin itself.

Check ropes with toggles are spliced upon the trail eye, by which the wheels can be lashed to check the recoil on firing.

Upon each bracket there is a stop to steady the carriage and a staple for strap to secure it when carried upon a cradle. The carriage with its wheels (removed from the axletree) forms a load for one mule.

The rammer and sponge heads are formed in one piece with the stave, the former recessed and fitted with a nut to take the wadhook worm.

Carriage for the Bronze 7-pr. of 224 lbs. or Steel of 200 lbs.

7-pr. carriage for bronze gun of 224 lbs. or steel gun of 200 lbs. Plate XIV.

This carriage is similar to that just described, but the brackets are not so nearly parallel and each is made stronger by a piece of angle iron riveted along the upper edge from the trunnion hole to the point, on the outer side, and at the same time the plate is lightened out, or pieces cut out, to decrease the weight. The trail plate is of rather different form to that of the preceding carriage; in future it will be similar to that of the 9-pr. M.L.R. carriage, Mark II., and to make the carriage sufficiently strong for the steel gun, a second transom will take the place of the horizontal stay, and also the axletree clips increased in strength.

The axletree and wheels belong to the special class; the latter are Madras pattern, 3′ 0″ in diameter, and have a track of 2′ 3″, with spokes of pedowk, and felloes of santa maria.

The carriage forms a load for one mule, the wheels for another.

The sponge is similar to that of the 9 or 16-pr. M.L.R.

Limber for the 7-pr. Steel of 200 lbs.

7-pr. limber.

The limber for use when practicable with the preceding carriage is of similar construction to that of the 4⅖″ howitzer (to be presently described) but fitted with light shafts of the Brandling pattern for single draught and carrying the ordinary mountain service boxes.

Carriage for the 4⅖″ S.B. Howitzer. (Special.)

4⅖″ S. B. howitzer. (Special.)

The carriage for the 4⅖″ howitzer, which was made for service on the coast of Africa, is of very simple construction. It consists of two brackets of ⅜″ iron plate, connected by an axletree, a collar bolt, and a trail piece.

The axletree is of special form, having near each shoulder a lug forged upon it, projecting at right angles to and upwards from the body; to this stay the bracket, which is slightly housed over the shoulder of the axletree, is riveted.

The trail piece is of the form adopted in the 9-pr. M.L.R. carriage, Mark II.

The wheels are Madras pattern, 3′ 0″ in diameter, the same as for the 7-pr. bronze of 224 lbs., and have a track of 2′ 4″. The washers are drag washers.

A metal trunnion bearing with metal capsquare is riveted to each bracket.

To support the nut of the elevating screw, which is the "common cross-handled" pattern, a piece of plate iron, in which the nut is riveted, is fitted between the brackets, its ends being bent at right angles, and riveted to the latter.

The point of the trail is fitted for a small traversing handspike, and an iron trail box is constructed between the brackets. Upon the right bracket is a portfire cutter, and upon the left staples to carry a portfire stick.

Limber for the $4\frac{2}{5}$" S.B. Howitzer. (Special.)

$4\frac{2}{5}$" howitzer limber. (Special.)

The frame of the limber is of angle-iron, with a summer of tee iron: it is attached to the axletree by a stay of plate iron riveted to each side of the frame and to a lug or projection on the axletree, similar to that on the axletree of the gun carriage, but shorter.

The wheels are the same as those on the gun carriage, and have the same track.

The limber is fitted with a pole with two cross handles for man draught.

It carries two long boxes, of teak with mahogany ends, to contain ten rounds each, which are placed back to back, and open next the wheel; they are each secured by a nib iron in rear, and by a thumb-screw in front, to projecting pieces riveted to the frame of the limber, and also by straps.

There are also fittings on the limber for carrying dwarf entrenching tools, &c.

$4\frac{2}{5}$" Howitzer Carriage and Limber, adapted for the ·45 Gatling Gun. (Special.)*

$4\frac{2}{5}$" howitzer carriage, adapted to ·45 Gatling. (Special.)

The $4\frac{2}{5}$-inch howitzer carriage is adapted to take the ·45 Gatling gun by fitting it with a saddle to receive the gun, and a nut in the proper position for the elevating screw, which increases the weight by 42 lbs. The saddle consists of two metal brackets connected by an iron tie bolt. The brackets stand in the trunnion holes of the carriage, and are secured there by the capsquare keys, while they have in themselves trunnion holes for the gun. A metal nut with cross handles for the elevating screw is pivoted in a little iron bracket with metal bearings, which is fixed to the carriage by passing the elevating screw of the howitzer through an eye at one end.

The limber is adapted for the Gatling gun simply by fitting it to take two limber boxes, each to contain two drums, which increases the weight by 52 lbs. The boxes are of Bessemer steel with top and bottom lined with wood, and are fitted with loop guard irons. They are placed across the limber and secured by nib irons and thumbscrews; one opens to the front, and the other to the rear.

CHAPTER V.—MISCELLANEOUS ARTICLES FOR MOUNTAIN SERVICE.

Arms, wheel.

Wheel arms for the support of the wheels of the carriage for the 7-pr. bronze of 224 lbs. or steel of 200 lbs.† when carried upon a mule are "near" and "off," and can be used with any general service saddle. Each is formed of a hollow cylinder of iron projecting from an iron plate to which it is fixed; both the plate and cylinder are covered with leather, and the latter is fitted with two straps with links for attachment

---

* Two carriages are now being made for the Gatling gun, on the plan of the carriage for the 7-pr. steel gun of 150 lbs. with 2' 6" wheels, having a track of 2' 1".

† The wheel arms for the 7-pr. steel of 150 lbs. are longer than these, and of different construction.



to the saddle, and with two smaller straps for securing the wheel. The weight of a pair of arms is 12 lbs.

Barrow, ammunition or store. The ammunition or store barrow, "China pattern," is a mahogany barrow mounted upon O. P. special wheels, 3′ 0″ in diameter, and fitted with folding sides, a movable tail board, bale hoops, and canvass cover.

Bearer, gun. The bearer for lifting the 7-pr. of 224 lbs. is a rounded bar of ash 2′ 8″ long, having a U-shaped iron at the centre to fit on the cascable and a pin to secure the latter by passing through the ends of the U.

The bearer used in Abyssinia with the 7-pr. of 150 lbs. served also for a splinter bar, when shafts were attached to the carriage. To lift the gun the bearer was lashed to the cascable.

Boxes, ammunition. (R.C.D. photo-lithographs, 1B, 1E, and 1F.) The ammunition boxes supplied for service in Abyssinia were constructed of cedar wood, covered with Russian duck and painted, the lid of each secured by a spring lock. In the shell boxes the shells stood in hollow copper cylinders lined with leather, and supported in copper trays.

Some ammunition boxes were also made of leather, painted, and the lids secured by straps; in these the internal fittings for the projectiles were the same as in the previous.

In both the foregoing descriptions of boxes the cartridges and projectiles packed in separate boxes, excepting in the case of the double shell.

Two leather boxes have been sealed for the 7-pr. of 224 lbs.,* one for common and the other for double shell. The box for the common shell is bound with iron, and the lid is attached by copper hinges and fastened by straps and buckles. The interior of the box is covered by a flap and divided by leather partitions to carry shells, cartridges, and fuzes, eight rounds, the shells held in leather cylinders, and the cartridges contained in a waterproof canvass cartouch. The box is fitted with a handle at each end, with a carrying strap, and with links for attachment to the saddle. When packed upon a mule it can be opened without taking it off the mule's back, and the lid when let down supplies a table for use in boring and fixing fuzes. The weight of the box (fitted for limber), empty, with cartouch, is 25 lbs. The box for the double shell is similar, but cannot be opened in the same convenient way when packed upon a mule; it carries shell, cartridges, and fuzes for five rounds, and weighs empty, with its cartouch, 27 lbs.

Box, general service. The leather box for general mountain service, to contain veterinary instruments and medicines, is a small deep box fitted with links at the back for attachment to the saddle, and also at the ends for a carrying strap; its weight empty is 8½ lbs.

Cart, hand, for 4⅖″ howitzer. (Special.) This hand cart is converted from the "China barrow" by cutting short the sides, removing the prop in front, and fitting the barrow with a pole for man draught, with a head board and with floating raves.

To admit of two or more carts being attached and drawn together an eye is fixed upon the end of the pole, and a limber hook with key upon the hind earbed.

The track is 2′ 5·5″, and weight 2 cwt.

Covers, pack-saddle. The packsaddle covers for the 7-pr. equipment are of canvass waterproofed; they are of two sizes, namely, 6′ × 6′ and 6′ × 4′, the latter being intended to cover the flaps which carry the entrenching tools. Each cover has a grummet at every corner for a lashing rope to pass through and secure it over the load.

---

* These are also suitable for the 7-pr. steel of 200 lbs.

The cradle used with the 7-pr. of 150 lbs. in Abyssinia was of wood, strengthened by iron; it was formed by the tree of the R.C.D. pattern saddle, and was suitable either for carrying the gun or its carriage and wheels, the latter on arms for the purpose.

Cradles. **(R.C.D. photo-lithograph, 1H.)**

A movable iron cradle was also fitted to some saddles of the Otago pattern for use in Abyssinia, it carried the gun or carriage with wheels in the same manner as the preceding.

(R.C.D. photo-lithograph, 1J.)

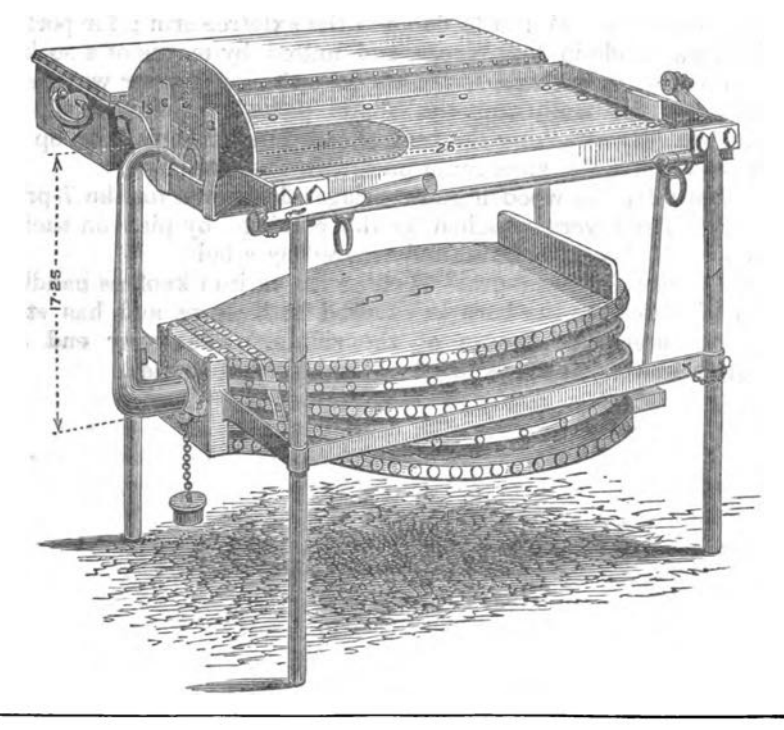
Two iron cradles are now sealed for the 7-pr. of 224 lbs., one to carry the gun and the other the carriage, while, as already mentioned, the wheels are carried upon wheel arms on a third mule. Each cradle is fixed to the saddletree, and consists of a simple framework of iron. *The cradle for the gun is rather narrower than that for the carriage, the gun rests in it, muzzle to the rear, the trunnions bearing upon the sides of the frame, and is secured by straps. The cradle for the carriage is similar to that for the gun, the carriage rests upon it, breast to the front, the axletree arms bearing upon the sides of the frame, and is secured by straps. The gun cradle with saddletrees, to which it is attached, weighs $16\frac{1}{8}$ lbs., and the carriage cradle with saddletrees, 16 lbs.

Leather flaps are pieces of stout leather, $32\frac{1}{2}'' \times 25\frac{1}{2}''$, fitted on the outer side with loops, &c., to carry entrenching tools, and at the back with links for attachment to the saddle. They are "off" and "near," and buckle together by means of a web strap across the saddle. A pair of flaps weigh 12 lbs.

Flaps for entrenching tools.

The portable smiths' forge for packsaddles consists of a rectangular iron tray, $25 \cdot 5'' \times 19 \cdot 375''$, supported upon four jointed iron legs, which are kept in position by sliding connecting bars. The tray is deepened out at one end to form the hearth, and fitted with a movable cast-iron back plate for the fire. The bellows are fixed underneath the tray to

Forge, portable.



* A similar cradle but of slightly different dimensions is made for the 7-pr. steel of 200 lbs.

the connecting bars of the legs, and have a goose-neck-shaped nozzle reaching upwards to the blast hole in the back plate; they are connected by a bar to a crank, which when the blast is required is worked by a lever handle. A tool box of wood with canvass-covered lid hangs upon one side of the tray. To pack the forge upon a mule the tool box is removed, the back plate, nozzle, &c., taken off and strapped upon the top of the bellows. The forge is then turned upside down, the bellows made to slide down upon the hearth, the legs folded, and the whole bound together by two straps for the purpose, when it can be hung by links, at one side of the tray, upon the saddle.

The anvil and anvil block are of the usual form, the latter has links at one edge for attaching it to the saddle, and a recess in one side into which the anvil packs and where it is retained by a pin. A 7 lb. hammer, a poker, and a slice also belong to the forge.

The forge complete forms a load for one mule; it weighs 217 lbs., and its tonnage is ·182 tons.

Holdalls, leather. Leather holdalls for carrying implements for the 7-pr. equipment are "off" and "near," each has links at the back for hanging it on the saddle.

Panniers, rocket, 9-pr. Leather rocket panniers were made for the Abyssinian expedition; they were fitted internally with leather cylinders to hold the rockets, and the lid of each was fastened by straps. The panniers buckled together by a web strap across the saddle, and were each supported by an iron rod fastened to its side by two straps, the ends of which rod rested in the hooks of the saddle.

Ropes, drag. The light drag ropes made for service in Abyssinia were of $1\frac{1}{2}''$ rope, $8'$ long, and served also as traces, having links attached to them at one end.

Shafts. To admit of mule draught when practicable, shafts were made for the Abyssinian gun carriage. Each shaft was merely a round bar of ash, with a socket or wheel iron to fit upon the axletree arm; for portability the shaft was made in two pieces, and united by means of a socket and pins. To attach the shafts to the carriage the gun bearer was lashed to the point of the trail, and the shafts passed through bands at its extremities. By attaching the trail of one gun carriage to a loop on the breast of another, the guns could be drawn in pairs.

The shafts for the wooden gun carriages first made for the 7-pr. were frame shafts, and were attached to the carriage by pins on their ends fitting into staples on the trail and secured by a bolt.

Tampeon. The tampeon for the 7-pr. is of elm with an iron knob as handle; the portion which enters the bore is covered with serge, and has strips of leather to enter the grooves of the rifling. The inner end of the tampeon has two small eyes for the attachment of a wad.

SECTION IV.—ENGINEER, TRANSPORT, AND OTHER CARRIAGES.

CHAPTER I.—PRINCIPLES OF CONSTRUCTION OF TRANSPORT CARRIAGES.

What has been said in Section II. on the construction of field artillery carriages, viewing them as travelling carriages, is, in a modified form, applicable to transport carriages.

These carriages are not required, in general, to move over such broken ground as artillery carriages may have to surmount, nor to move at such rapid pace. Hence, and bearing in mind also their special purpose, namely, the conveyance of stores, we may regard their essential qualities as the following :—

Essential qualities.

"Capacity to receive and strength to convey their load."
"Stability in carrying it."
"Lightness of draught and moderate mobility."
"Durability, simplicity, and facility of shipment."

Before discussing these qualities in detail it will simplify the subject to assume that the vehicles to be employed are wagons,* (a few remarks upon carts afterwards being added), that the load to be conveyed and team to draw it are fixed, and also, for the time, to neglect the question of springs.

"Capacity and strength."

As to "capacity for load," the first-mentioned requisite; a wagon should be able to receive the load it is destined to carry in a reasonably bulky form, without it being necessary to pack the load very high, which is inconvenient and otherwise objectionable. In point of strength, the wagon should, as regards the material of which it is constructed and the scantling of the various parts, be able to support with safety its given load and to take it, without breaking down, over a bad as well as over a good road, or even across a small ditch or other obstacle.

Now, the form of the fore carriage and the manner of its connexion with the hind carriage or body, influences to a very considerable degree the capability of the wagon to pass obstacles without hurt. For example, the fore carriage first meets any obstacle or rut to be passed, and as it crosses it rises and falls or falls and rises, while the hind carriage is still on the original level. This action necessarily throws a strain upon the connecting arrangement of the fore and hind carriages and upon their surfaces of contact, to be repeated when the hind wheels arrive at the same obstacle. In most wagons the connexion between the fore and hind carriages is by a long vertical main pin, and the surfaces of contact, wheel plates or otherwise, are at some distance around or in front and rear of the point of connexion. This being the case, it is evident that the strain in question will be less in proportion as the distance from the main pin or point of connexion to the surfaces

* That is, "wagons not limbered," because it is undesirable to leave spare space between the axles of no use for loading, as in a limbered wagon.

of contact is decreased, and also as the play of the pin is increased. (The strain upon the pin itself will of course increase with the amount of play allowed.) Thus the more nearly the bearing surfaces of the fore and hind carriages approach to unite in one point, as they do in a limbered wagon, and the more play there is at the point of connexion, as in the same description of wagon, the more strong will the wagon be for passing broken ground.

To reducing the bearing surfaces in an ordinary wagon, *i.e.*, one without limber, to one point, there are, however, objections, namely, that so doing decreases the "stability," and, under certain circumstances admits of the likelihood of the wagon body being very much strained.

"Stability."

The next essential quality in a wagon is "stability," that is to say, a wagon should not overturn when tilted sideways through a considerable angle. As has just been stated, having the hind carriage bearing upon the fore carriage at one point only decreases the stability; because then the base formed by joining the bearing points of the body is a triangle, outside of which the vertical from the centre of gravity will soon fall, supposing the carriage gradually tilted over; and of course as soon as this happens the wagon upsets.

We have, however, already seen that one bearing point between the fore and hind carriage makes a wagon much better adapted for going over rough ground; from which and from what has just been said about stability on three bearing points, it would appear that great stability and at the same time perfect construction as regards strength are incompatible, but that one quality must be more or less sacrificed to the other, unless the wagon be of the form of a limbered wagon, similar to a field gun carriage or gun ammunition wagon.

"Mobility."

With regard to the third requisite in a wagon, namely, "mobility," the conditions which influence the draught have already been sufficiently dwelt upon when speaking of artillery carriages.

The height of the hind wheel of transport wagons varies from 4′ 2″ to 5′ 0″ (the now approved height is 4′ 8″); the greater it is the more advantageous for draught, but a high wheel carries with it the evil of increasing the height of the bottom of the wagon for loading and of diminishing the stability. The height of the fore wheel should also be at a maximum as regards ease of draught. In most wagons, the height of the hind wheel being determined, that of the fore wheel is made a maximum consistent with locking under, so that the wagon may be able to reverse in as short a space as possible. In some wagons, however, this point is sacrificed, and the fore wheel made of equal diameter to the hind.

"Durability," &c.

"Durability" and the remaining essential qualities of a wagon need no comment.

Carts.

Carts.

Carts are used for transport service as supplementary to wagons, for they furnish convenient means of moving small loads. They could not entirely take the place of wagons, for their capacity is not sufficient, and so many more carts than wagons would be required, that columns of route would be too long. Carts have, however, another and more serious defect, namely, of being much more fatiguing to the shaft horse, not only from the amount of weight which must necessarily be thrown upon him, but from the jolts or shocks which more or less are communicated to him as the cart passes over rough ground.

The position of the centre of gravity of the cart (and load) is the only point which needs particular notice in the construction; it should always lie to the front of the axis of the axletree, and only so far so as to throw a moderate weight upon the shaft horse. It might, at first sight, be supposed that it would be better to balance the cart exactly on its axletree and not have any pressure upon the shaft horse when the cart is at rest. If, however, this was done, it would be found that the inequalities of even a tolerably good road would produce such jolts that the horse would be more fatigued than with a constant moderate pressure upon his back.

Springs.

Springs.

The advantages obtained by the addition of springs to a wagon or cart are,—

"Lightening of the draught;"

"Saving to the carriage and load in passing over rough ground."

In order that a wagon or cart without springs may surmount each successive obstacle of a rough road, the vehicle, and as a consequence its load, have to be raised to the height of the particular obstacle as the wheels pass it.

Suppose now the same wagon or cart to be fitted with springs, the body of the vehicle, with the load, will not have to be raised to the height of each obstacle; for as the wheels surmount it the springs will yield to some extent, consequent upon their pliancy and the vis inertia of the weight above them. In this manner it arrives that much less exertion is required to make a wagon with springs pass an obstacle of given height than to make the same wagon without springs pass it; in other words, the draught of the spring wagon is the easier.

Springs have also the advantage of saving the wagon and its load. This they do by lessening the shocks due to the badness of the road, acting, not only by reducing the height due to an obstacle through which the body and load must rise and fall, but also by rendering the blow less severe; in fact, they convert what would otherwise be a blow into a pressure.

On the fore carriage of a wagon springs are particularly useful, as they allow of some yield, when by reason of the unevenness of the ground extra pressure is thrown upon any part in particular of the bearing surfaces.

Two comparatively slight disadvantages accompany the use of springs: one, that the body is not so perfectly rigid over its axles as if without springs, some slight lateral motion of the body and load above the axles being a necessary consequence of the nature of the connexions. The second disadvantage is that the use of springs necessitates the bottom of the wagon being rather higher than it otherwise need be. Both these points affect the stability, and the last-mentioned, also convenience of loading.

It may also be urged that the addition of springs renders the construction of a cart or wagon more complicated and delicate. No doubt to some extent this is the case, but the springs used in the service, namely, the "semi-elliptical steel," are simple in construction and easily repaired.

Springs on a wagon or cart should be of such strength that with the full load and the wagon at rest they should not yield more than half the distance (measured along the central radius of the spring) through which they would have to bend to become straight.

The strength of a steel spring is proportional to the number of leaves and to the width and thickness of each leaf, while it is inversely proportional to the span, thus:—

Let s = span or length in inches of the spring,
b = breadth in inches of a leaf,
t = thickness in sixteenths of an inch of a leaf,
n = number of leaves,
c = a constant,

then, the working strength of a spring in tons $= \frac{b \times t^2 \times n}{s \times c}$, where $c = 11 \cdot 3$; and the elasticity or deflection per ton of load $= \frac{s^3 \times c}{b \times t^3 \times n}$ where $c = \cdot 105$.

CHAPTER II.—ENGINEER CARRIAGES.

Table. The following table gives the carriages peculiar to the engineer train :

Description.	Weight, empty.			Tonnage.
	cwts.	qrs.	lbs.	tons.
Pontoon wagon, Mark II. - - - - } Trestle wagon, Mark II. - - - - }	15	1	24	6·470
Wire wagon, including drums, barrow, and ladder, Mark I.	21	3	11	7·925
Office wagon, including spare wheel, Mark I. - -	21	3	14	12·787
Miner's wagon, Mark II. - - - -	21	1	0	6·459
Forge wagon, including forge complete, Mark II. -	26	2	17	7·872
Store wagon, Mark I. - - - - -	20	1	18	6·360
Tip cart, Mark II. - - - - - -	9	0	14	1·937

Both wagons and the cart have third class, Madras pattern,* wheels, with 3″ tire : the fore wheel of the wagons is 3′ 6″ in diameter and locks under, and the hind wheel, which also serves as the cart wheel, is 5′ in diameter ; it is however proposed to alter the diameters to 3′ 4″ and 4′ 8″ respectively.

The track of the wagons is 5′ 10″ and of the cart 5′ 2″. It is however under consideration to reduce the track of all the wagons, except the pontoon wagon, to 5′ 2″.

The axletrees of the wagons are round in the body and have the arms enlarged at the base; the fore axletree is arched and slightly longer than the hind in the body to give the fore wheels the same track as the hind. The axletree of the cart is square in section, being bedded in wood.

The wagons are mounted upon semi-elliptical springs, all, except the pontoon and office wagons, having check as well as side springs.†

Except the pontoon, all the wagons have the same fore carriage, and, the pontoon included, are fitted with general service, double bar, frame shafts, which can be placed either for single or double draught.

The cart is fitted with field shafts, near and off, for either single or double draught.

* The older carts have O.P. wheels.

† It is proposed in future to do away with the check spring and make the strength of the side springs in all wagons the same as they are now in the pontoon wagon, viz., fore 10 leaves and hind 12 leaves.

The framework of the wagons and cart is of oak and the boarding of yellow deal: the boxes are of deal with elm ends, and the lids covered with canvass.

Pontoon Wagon. Mark II.

Pontoon wagon. Mark II. (R.C.D. photo-lithograph, 124.)

The body of this wagon is formed by two sides, 13½′ in length, bolted in front to a bolster placed beneath them, and in rear to a cross bar placed over them. The sides in rear are supported on the springs, which rest in axle blocks upon the shoulders of the axletree, and are secured by axle staples and clip plates. In front the bolster with a wheel plate rests upon the fore carriage, the latter being connected with the body by a main pin. The sides of the wagon have a slope of 3° when the wagon stands upon the level.

The fore carriage is formed by four futchells, a cross bar, splinter bar, bolsters and a wheel plate connected in the usual manner, and attached by springs to the fore axle in the same manner as the body to the hind axle. Over the front of the futchells there is a shallow box fixed, and at each end of the splinter bar a plate to form a step.

For the pontoon boat to lie upon, four raised rests are fitted upon the frame of the body, two immediately above the hind axletree upon a cross bar over the sides and two on the bolster immediately over the fore axle. The wagon standing upon the level, the upper surfaces of the rests lie in a horizontal plane; upon its outer end each has a metal friction plate which is formed into a stop to keep the pontoon in position. Supposing the boat upon the wagon, there is a space for some of the baulks of the superstructure to lie underneath it between the rests, and a small iron-shod bar is fitted to the front of the bolster to take their bearing as they are pushed up into this position.

Beneath the sides are two vertical cross frames or "chess carriers;" the hind cross bar of the wagon forms the upper bar of the hind frame, while the other frame is placed 9′ more to the front. In the hind frame there are two hinged pieces, which to admit of the chesses being placed must be raised; on being turned down again, and secured, when the chesses are in the carriers, they keep them in position.

The wagon is fitted with a drag shoe and chain on the near side and to carry an anchor on the off side; there are also fittings for carrying entrenching tools and stores.

Pontoon boat.

The pontoon can be used either as a pontoon in a bridge or as a boat: its outside dimensions are 21′ 1″ × 5′ 1″ × 2′ 6½″ in depth; its weight is 7 cwt. 1 qr. 14 lbs., and its tonnage 8·059 tons. In horizontal section it is rectangular, its sides are nearly straight and vertical, and its ends rounded. The framework, which is very light, is of yellow deal and rock elm, the straight parts being made of the former, and the bent of the latter. The frame is boarded over with yellow pine, and each side of the boarding covered with canvass attached by Clarkson's indian-rubber solution. The canvass is covered with knotting before the pontoon is painted, and the bottom protected by four longitudinal ribs shod with iron friction plates. The pontoon has eight wood handles along each side, about half-way up, six attached by rope grummets and two by wire, the latter serving as eyes to receive lashing ropes, it has also a ring at each end for a cable, and is fitted with four rowlocks along the gunwale at each side, and at each end with one for a steering oar; it has also fitments for securing the saddle beam.

Trestle Wagon. Mark II.

Trestle wagon. Mark II.

The trestle wagon is the same as the pontoon, and carries part of the superstructure of the bridge without a pontoon.

Wire Wagon. Mark I.

Wire wagon. Mark I. (R.C.D. photo-lithograph, 121.)

The body of the wire wagon is formed by two sides and two summers mortised into a hind earbed and a front cross bar. The fore part only of the frame is boarded over, the hind part being left unboarded to admit of six drums or reels, on which the telegraph wire is coiled, being carried, three between each side and the summer next it, and also, of a ladder between the summers. The connexion of the body with the hind axle and fore carriage is the same as in the pontoon wagon.

The fore carriage differs from that of the pontoon wagon in having shorter futchells, no box over the front ends of the latter, but a board over their hind ends.

On the sides and summers of the wagon body there are iron socket plates for the spindles of the drums to rest in, and in which they are secured by capsquares, each retained by a turnbuckle. An arrangement is fitted on either side of the wagon for winding up the wire on the hindermost reel: it consists of a wooden drum fixed upon the back of the hind wheel of the wagon and concentric with it; from this an endless indian-rubber band passes to the rear round a small band wheel held in an iron bracket upon the side of the wagon. The axis of the band wheel lies in prolongation of the spindle of the wire drum, and has upon its inner side a clutch, a corresponding clutch to which is placed upon the spindle of the drum. The band wheel is movable on its axis, and by means of a lever handle its clutch can be thrown in or out of gear with the clutch of the wire drum. When the clutches are in gear and the wagon moves forward the wire is wound up. Two small iron rollers are fixed on the earbed of the wagon immediately in rear of the wire drum for the wire to run over.* To keep the ladder which is carried between the summers in its position, there is a high wood stop fitted upon the hind earbed. To support the drum barrow when it is carried under the hind part of the wagon, there are two chains with hooks, which hook into eyes upon the axle of the barrow, while the handles of the latter rest upon the hind axletree of the wagon.

On the boarded portion of the wagon frame there are cleats upon which two boxes are secured; the front box is much wider than the hind, both are fitted with standing guard irons and serve as seats; they are placed 14″ apart, and in front of the front box there is a footboard. To the back of the hind box there is a waterproof canvass cover attached, which can be drawn over the wire drums when required.

The wagon is fitted with a drag shoe, and has strapping for carrying tools and small stores.

Drums for wire.

The drums upon which the wire is coiled consist each of two circular frames, 2′ 0″ in diameter, of oak shod with iron, placed 11″ apart and connected by ribs of deal, which latter are so fixed as to form a hollow cylinder 9″ in diameter concentric with the oak frames. The wire is wound round the cylinder and the ends or frames keep it in its place. An iron spindle is passed through the drum, upon which the latter is supported, either in the wire wagon or drum barrow. One end of the spindle is square to receive either the clutch of the winding-up arrangement of the wagon, or a cranked handle for the same purpose. A terminal is fixed upon one end of the drum; the weight of the latter is 1 qr. 2 lbs., and of the wire it carries 133 lbs.

---

* It is proposed to increase the length of the wagon by 1″.

The barrow is for the purpose of carrying a single drum when required: it consists of two sides of oak, the hind extremities of which are formed into handles, connected by two cross pieces. The frame so formed is attached to a cranked axle by two stout springs. The axle is fitted with iron wheels 2′ 0″ in diameter, which have double steel spokes and a metal bouche or box; their track is 2′ 0″. In rear there are two movable iron legs to support the sides when the barrow stands upon the ground. Upon the upper surface of each side piece there is a socket plate, the same as on the wire wagon, for the drum spindle to rest in. The handle by which the drum is turned for reeling up the wire is carried upon a stud upon the hind cross piece. Upon the front cross piece there is an eye for the attachment of a drag rope, and upon the axletree there are eyes, as before mentioned, for the attachment of the wagon chains.

Drum barrow.

The telegraph pole is of iron tubing made in two lengths of 10′ and 8′, which unite by a bayonet joint. A ring for the attachment of three guy ropes fits over the point of the upper length.

Telegraph pole.

The guys are of white line, each is 15¾′ long, with a hook at one end and knot at the other, and is fitted with a beech runner.

The telegraph ladder is made of ash with oak rounds, it is 17′ long, in two lengths, which can be used separately or together.

Telegraph ladder.

The crook stick for raising the telegraph wire is a slight ash stave fitted with a double crook and roller between; its total length is 7′.

Stick for raising wire.

Office Wagon. Mark I.

Office wagon. Mark I. (R.C.D. photo-lithograph, 122.)

The frame of this wagon is cranked, formed in the usual manner, and boarded over.* The sides, end, and roof, which is arched, are fixtures; the first mentioned are sufficiently high to admit of a man standing inside, and all are covered inside and outside with canvass. In each side there is a window, and in the off side there are apertures to admit the telegraph wires. The back of the wagon is closed by a large folding door of mahogany, and for convenience of getting into the interior a sliding step is fixed underneath the back of the wagon. The interior is fitted with cupboards, bench, terminals for the wires, &c.

The body of the wagon is attached to the hind axle and to the fore carriage, as in the pontoon wagon, except that the hind axle lies over instead of under the springs.

The fore carriage is the same as that of the wire wagon, but not fitted with a board over the hind extremities of the futchells.

On the fore part of the body a large box is carried, serving as a seat.

The wagon is fitted with brakes on the hind wheels, connected by a spindle underneath the body, and put in action by a cranked lever on the right side, which is worked from the box by foot.†

There are fittings to carry a spare hind wheel between the driving box and the body; there are also fittings for carrying small stores.

The office wagon may be fitted in four other ways besides a telegraph office, viz., as an office wagon, printing wagon, lithographic wagon, or photographic wagon: when used as a printing wagon, it is made more lofty by a well being added to the bottom.

Miner's Wagon. Mark II.

Miner's wagon. Mark II.

The body ‡ of this wagon consists of a frame formed in the usual manner and boarded over: on the hind part of this a large box is formed

* It is proposed to increase the length of the wagon by six inches.

† It is proposed to substitute a drag shoe for this brake.

‡ It is under consideration to substitute the body of the R.A. general service wagon for the present body in this wagon, and also in the forge and store wagons.



by movable sides, headboard, an arched canvass-covered roof, and in rear, folding doors. The sides 3′ 2″ long, and 3′ 0″ high, are held in position by iron standards.

The fore carriage is the same as that of the office wagon.

On the fore part of the wagon a box, fitted as a seat, is carried, and behind it over the centre of the wagon another larger box, not fitted with guard irons, but with a handle at each end. The wagon is fitted with a drag shoe and chain, and has strapping for entrenching tools, &c.

Miner's truck. The miner's truck is a small wooden truck, about 11″ deep by 22″ long, and 12″ wide.

Forge Wagon. Mark II.

Forge wagon, Mark II. The body consists of a frame 12½′ long, boarded over, the sides of which are strengthened by iron plates.

The fore carriage, &c. are the same as in the two wagons last described.

The forge is carried upon the hind part of the wagon between two cleats which steady it, and is secured by pins in rear, and by straps at the sides.

Upon the fore part of the wagon two boxes are carried, similar to those on the miner's wagon, and between the larger one and the position of the forge there are cleats for carrying the anvil, vice box, and two other boxes, the latter two one on the top of the other. The anvil block is carried upon the bellows.

The wagon is fitted with a drag shoe and chain, and for carrying entrenching tools, &c.

Forge. The forge frame is of oak or teak with folding legs; the hearth is of wrought iron with hinged back, and supported on ferules over one end of the frame, while the bellows are hung between two standards over the other end. The coal boxes and water trough are of deal; the former are carried on the sides of the frame, and have staples in them to receive bale hoops which support a canvass cover over the forge. The weight of the forge is 4 cwt. 3 qrs. 14 lbs.

Store Wagon. Mark I.

Store wagon. Mark I. (R.C.D. photo-lithograph, 123A.) The frame of the body, the fore carriage, &c., of this wagon are the same as in the miner's wagon, but the body has hinged sides 8′ 9″ long, movable head and tail boards, and is fitted with bale hoops, canvass cover, and floating raves.

Over the fore part of the body the usual box is carried, which serves as a seat. The wagon has fittings on the hind earbed for a pulley; it carries a drag shoe with chain, and has strapping for entrenching tools, &c.

Tip Cart.* Mark II.

Tip cart. Mark II. The tip cart is formed of an under frame and body. The under frame consists of four futchells, a splinter bar, and an axletree bed. The frame of the body is formed in the usual manner, boarded over and fitted with movable sides, head and tail board: it is hinged to the outer futchells of the under frame by a bolt in rear of the axletree bed, and is secured to the splinter bar by a pin with a handle at the end by which to move it.

The cart is fitted with bale hoops, canvass cover, and floating raves; of the latter, one on each side and a folding one upon the tailboard.

A small locker is formed between the summers under the cart at the back.

There are fittings for carrying entrenching tools.

* The transport tip cart will probably supersede this.

The Lifting Jack.

The lifting jack is very similar to the common field jack, but the wood pedestal is lower, and the pin holes in the iron fork continued further down to admit of the jack being used with the low fore wheel, also the upper side of the counter-lever is curved to receive the axletree. Its weight is 19½ lbs.

The lifting jack.

CHAPTER III.—REGIMENTAL CARRIAGES.

Small arm ammunition cart. Mark I.

The only carriage peculiar to the Line is the small arm ammunition cart; its weight is 8¼ cwts. and its tonnage 2·468 tons.

The frame of the cart is formed by two sides, and a summer of tee iron, bolted in rear to a cross piece of tee iron, and in front to a splinter bar of plate iron, trough shaped. The frame is boarded over with yellow deal and fitted with sides, head and tail board of the same. The tail board and sides are hinged to the bottom, the latter not extending to the splinter bar, but leaving a space for a platform board in front. The headboard is connected by hooks and eyes. An arched canvass-covered roof is bolted to the sides and headboard, and the interior of the box, so formed, is divided longitudinally into eight compartments, each to contain two small arm ammunition boxes. The tailboard, when up, keeps the boxes in position, and when down is supported by chains, forming a convenient shelf on which to draw out the boxes.

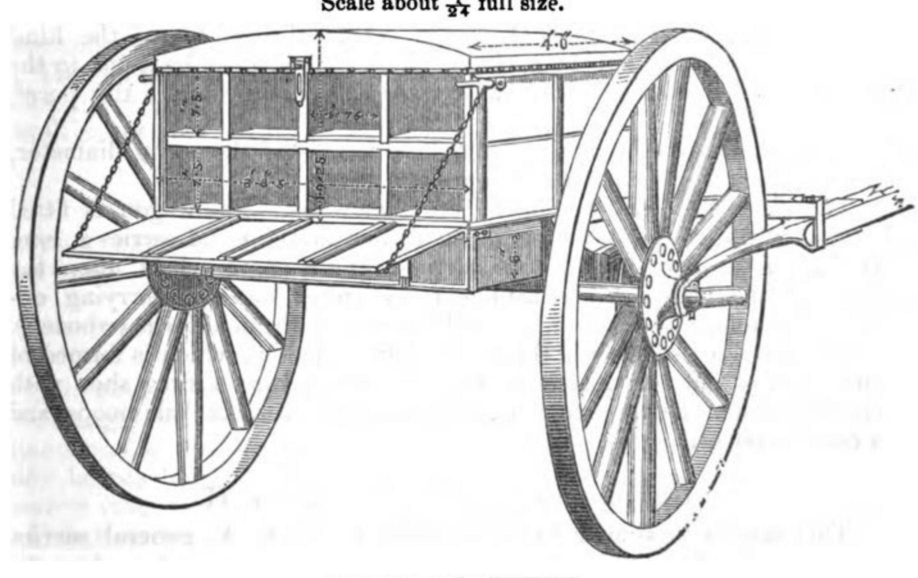
The sides and summers of the frame are housed in and bolted to the axletree bed, which is of ash, and in which the axletree is secured in the usual manner.

The wheels are Madras pattern, second class, 5′ in diameter, and shod with a tire 2½″ wide, with a track of 5′ 2″. They are peculiar in having spokes and felloes of the third class scantling.

The splinter bar is fitted for double draught in the same manner as field limbers, and the shafts used are the field, near and off, but slightly lightened from the point to the splinter bar.

Under the hind part of the wagon a locker is formed, and upon the near side a pocket is fitted.

Scale about $\frac{1}{24}$ full size.



CHAPTER IV.—TRANSPORT CARRIAGES.

Table.

The following table gives the wagons and carts at present in use for transport service :—

Nature.	Capacity.			Load.	Wheels.						Weight.			Tonnage.
	Length.	Width.	Depth.		Class.	Nave.	Diam. of Fore.	Diam. of Hind.	Width of Tire.	Track.				
	ft. in.	ft. in.	ft. in.	cwts.			ft. in.	ft. in.	in.	ft. in.	cwts.	qrs.	lbs.	tons.
Wagon, G.S., Mark I.	8 9	4 0	2 0	30	III.	Wood -	4 2	4 2	3	5 10	16	1	0	3·500
Wagon, G.S., Mark II.	9 7	4 1½	2 0	30	III.	Wood -	3 4	4 8	2½	5 8*	17	0	15	4·360
Wagon, spring, heavy, Mark I.	10 1	4 3	2 0	40	II.	Madras	3 6	5 0	2½	5 2	23	1	0	4·177
†Wagon, spring, light, Mark I.	8 3½	4 3	1 8	30	III.	Madras	3 0	4 6	2	5 2	15	3	4	3·164
Wagon, bread and meat, Mark I.	10 4	3 11	2 9½	40	II.	Madras	3 6	5 0	2½	5 2	29	3	0	8·604
Wagon, bakery, Mark I.	10 4	3 11	2 9½	40	I.	Madras	3 6	5 0	2½	5 2	26	2	13	8·604
‡Wagon, oven, steam.	—	—	—	—	II.	Perkyns	3 6	5 0	2½	5 9		—		—
Wagon. water	—	—	—	—	III.	Wood -	3 0	5 0	3	5 2		—		—
§Cart, spring, iron frame, Mark I.	5 5½	4 1	1 11	30	II.	Madras	—	5 0	2½	5 2	‖12	0	17	2·443
Cart, tip, iron frame, Mark I.	6 0	4 1	1 11	30	II.	Madras	—	5 0	2½	5 2	‖11	2	3	2·112
Cart, Maltese, Mark II.	—	—	—	30	III.	Wood -	—	5 0	3	5 2	5	2	9	1·750

* In future to be 5′ 2″. † This wagon is to be converted to an ambulance. ‡ Made by Mr. Perkyns.
§ Carts of this nature will in future have third class 4′ 8″ wheels, which will decrease the weight by about 1 cwt. and the tonnage by ·204.
‖ If with Perkyns' wheels add 2 qrs. 12 lbs.

Besides the above, there are many carriages of obsolete patterns still in existence, such as, Flanders wagons, bread wagons converted from ambulance wagons, &c.

General Service Wagon. Mark I.

G. S. wagon. Mark I.

The wagon is formed of a body supported over a fore and hind carriage: the body rests in housings cut in the bolster of the hind carriage, and is secured by a chain, while it is pivoted by a pin to the hind part of the fore carriage, which pin also passes through the perch of the hind.

From the wagon having fore and hind wheels of the same diameter, it is frequently known as the "equirotal" wagon.

The sides, head and tail board are removable. The wagon is fitted with G.S. frame shafts for single or double draught and carries a long box upon the front of the fore carriage, and a spare wheel upon the front of the body; it has fittings for a pulley, and for carrying entrenching tools; also, when required, for taking the field forge (wooden).

The articles issued with the carriage are, a pulley, which is formed of two sides of oak connected by two iron cross bars, a drag shoe with chain, box for the fore carriage, two floating raves, six bale hoops, and a canvass cover.

General Service Wagon. Mark II.

G. S. wagon. Mark II.

This wagon is similar in construction to the R. A. general service wagon, but lighter and weaker. Its axletree arms are enlarged at the



base, and up to the present the wheels have been made with wood naves and metal pipe boxes.

General Service Wagon, Spring, Heavy. Mark I.

G. S. heavy spring wagon.

The frame of the bottom of this wagon is formed of tee iron; the parts, namely, two sides, two summers, and two end pieces, are riveted together, the extremities of the summers being set down under the end pieces, so that the upper surfaces of the whole are flush. The bottom boards are of yellow deal, and riveted across the frame, the remainder of the boarding is also of the same. The standards of the sides are of iron and hinged to the bottom, and the head and tail boards are removable.

The springs are semi-elliptical, the hind springs are attached to scroll irons on the frame, and connected with the hind axle by axle staples and clip plates, a small block of wood being placed between each spring and the butterfly flaps of the axle. A check spring is attached to a bar between the summers over the hind axle, in the same manner as the side springs to the axle. Under the front of the frame, joint stays are bolted, and to these the upper wheel plate is secured by a horizontal bolt keyed in rear. This arrangement was to allow of free oscillation of the body over the fore carriage, but not being found to answer, the attachment of the wheel plate to the body was made rigid by the addition of an iron stay from each side of the frame to the wheel plate.

The frame of the fore carriage is a solid forging, with four arms, placed diagonally with the body; the ends of the hind arms form points of attachment for the side springs, while the ends of the fore arms are bent round and have the splinter bar bolted to them; these arms have scroll irons forged upon them for the attachment of the fore ends of the side springs. In the centre where the arms meet, there is a hole to receive the main pin, which connects the fore and hind carriage. The under wheel plate is bolted to four lugs forged upon the arms. The splinter bar is of plate iron, trough shaped, and is fitted with frame shafts for single or double draught, and with links for trace hooks, the wagon is also fitted for pole draught. The side and check springs are attached to the fore carriage, and the former connected to the axle as in the hind carriage.

A locker is formed in the fore part of the wagon body, and a smaller one under the hind part of the body between the summers.

The wagon has floating raves, bale hoops, canvass cover, and drag shoe; it is fitted for carrying a spare fore wheel, entrenching tools, and small stores.

General Service Wagon, Spring, Light. Mark I.

G. S. light spring wagon. Mark I.

This wagon is similar in construction to the heavy spring wagon, but much lighter and weaker; the frame of the body is of angle iron.

Bread and Meat Wagon. Mark I.

Bread and meat wagon. Mark I.

The hind carriage or body of this wagon is cranked in form, the frame is of angle and tee iron secured at the corners by angle plates. The standards of the sides are of iron, and are bolted to the bottom, the side boards being riveted to them. Along the top of each side a narrow rave is riveted, upon which the top of the wagon rests and to which it is bolted; these raves are strengthened by iron stays to the side, the upper ends of which are formed into hooks. The top of the

wagon consists of an arched canvass-covered roof of deal, to which are hinged two side pieces, having in them lattice ventilators, these pieces, as already mentioned, rest upon and are bolted to the raves. The rear of the wagon is closed by two boards, one turning down in the usual manner of a tailboard, the other hinged to the roof and turning upwards. The upper part of the front of the wagon is closed by a similar board, the lower part being fixed, and a locker fitted as driving seat formed in front.

The interior of the body is lined with zinc, and fitted with movable wooden trays.

The connexion of the springs and of the hind axle is the same as in the straight-bodied wagon, except that the axle lies above instead of beneath the side springs. Under the fore part of the body bolsters and a wheel plate are fixed for its bearing upon the fore carriage.

The fore carriage* is formed of four futchells of tee iron, riveted in rear to a cross bar of the same, and in front to a trough-shaped splinter bar. The futchells are housed in and bolted to oak bolsters, one above and one below them, to the latter the check spring is attached, and to the former as well as to two wheel bolsters, the wheel plate is fixed. Upon the outer futchells there are scroll irons for the attachment of the side springs. The splinter bar is fitted for draught as in the straight-bodied wagon.

The wagon is fitted with a drag shoe and chain, and strapping for carrying stores, &c.

Bakery Wagon. Mark I.

Bakery wagon. Mark I.

This wagon is similar in the construction of the body to that just described, but the roof instead of being hinged to its side pieces is fixed on sliding standards, so that it can be raised when required, canvass flaps being attached to cover the opening made, when it is so raised. Instead of lattice ventilators, in each side piece there are two glass windows protected by wire. The interior of the body is not lined with zinc, nor fitted with movable trays.

The fore carriage, &c., is the same as in the heavy spring wagon.

Steam Oven.

Steam oven.

The steam oven is a patent of Mr. Perkyn's, and consists of a long sheet iron oven, resting, slightly inclined to the rear, in a kind of iron cradle which forms the hind carriage, the fore carriage being the same as that of the heavy spring wagon. The interior dimensions of the oven are $9' \times 3' \times 1\frac{1}{2}'$; its door is in front, and it is heated by small steam pipes which run along its roof and its floor. These pipes are hermetically sealed, and pass from the fire-place, which is situated in the rear and lined with fire-brick. Rising from the top of the fire-place, there is a flue fitted with a cowl, and round the base of the flue a boiler is formed. Over the fore part of the oven there is a driving seat fixed, the foot-board for which is hinged, and can be folded out of the way when the oven is in use.

Water Wagon.

Water wagon.

The body of this wagon consists of a wood frame formed by two sides connected to an axletree bed in rear, and to bolsters in front, a

* The first wagons made had the same fore carriage as the straight-bodied wagon.

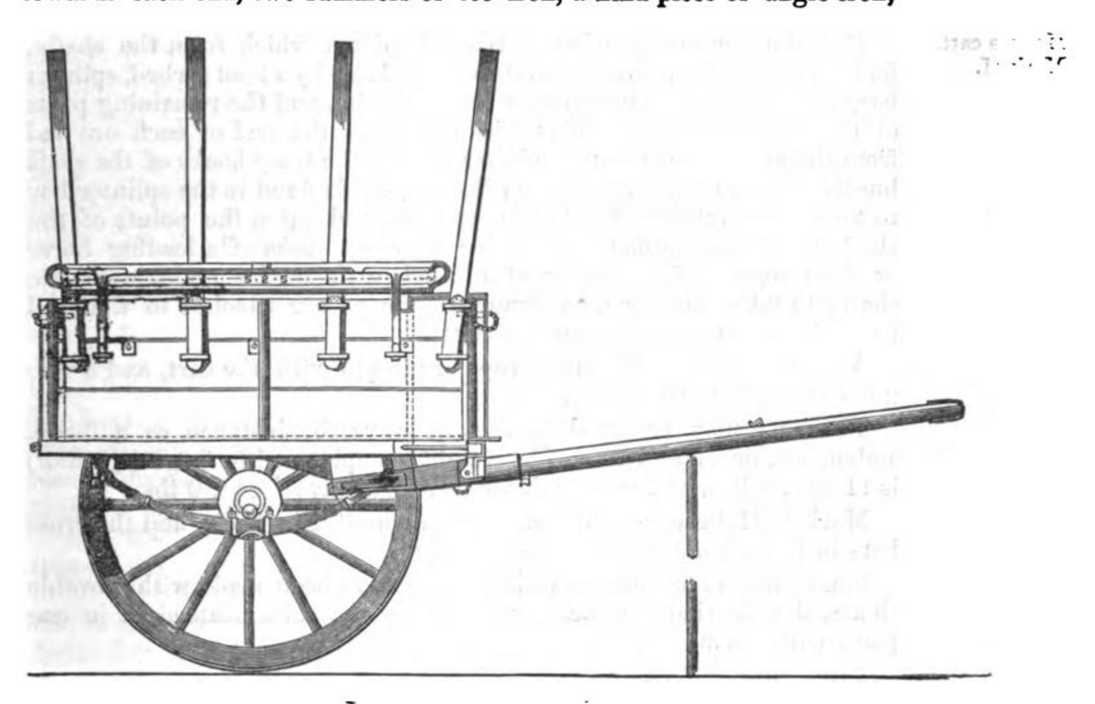
wheel plate being bolted beneath the bolsters. The water barrel rests, inclining to the rear, between the sides upon the axletree bed and upon cross bars, and is secured by iron bands. The front of the frame is fitted with a long box, which serves as a seat.

The fore carriage is a simple wood frame formed by two futchells, a splinter bar, and bolsters without a wheel plate, but with short friction plates. It has frame shafts, and is fitted for single, double, or pole draught.

* SPRING CART, IRON FRAME. MARK I.

Spring cart. Mark I.

The frame of this cart is formed of two sides of angle iron, tapering towards each end, two summers of tee iron, a hind piece of angle iron,



and a trough-shaped splinter bar, which are riveted together. Each side and the tailboard has three joints connecting it to the frame, and the headboard is movable. The springs, side and check, are semi-elliptical, and attached as in the spring wagons. The cart is fitted with special shafts for single or double draught. A small locker is formed at the rear between the summers, and there are fittings for carrying entrenching tools, &c.

Floating raves, bale hoops, and canvass cover are issued with the cart.

TIP CART, IRON FRAME. MARK I.

Tip cart. Mark I.

The frame of the body is formed of angle iron in a very similar manner to that of the spring cart, the sides, head and tail boards are also similar to those of the latter cart, but the tail as well as the head board is removable. Upon the sides and summers eyes are riveted

* No more of this nature will be manufactured.

to receive the connecting bolt which attaches the body to the under carriage.

The under carriage is formed of four futchells of tee iron riveted to a trough-shaped splinter bar of plate iron and bolted to a wooden axletree bed. Upon the hind part of the axletree bed there are eyes for the connecting bolt corresponding to those on the body.

The axletree is let half-way into the bed and secured by clip plates. A tipping bolt secures the body to the splinter bar. The arrangements for draught are as in the spring cart.

Floating raves are issued with the cart.

Maltese Cart, Common. Mark II.

Maltese cart. Mark II.

The Maltese cart consists of two side pieces, which form the shafts, bolted across an axletree bed, and connected also by a hind earbed, splinter bar, and six slats. The axletree bed is of elm, and the remaining parts of the frame of ash. Chains with a ring at the end of each are led from the axletree bed to the splinter bar for the trace hooks of the shaft horse. Upon the near side a small outrigger is fixed to the splinter bar to take a swingletree for double draught, and upon the points of the shafts there are eye plates to receive the trace hooks of a leading horse or drag ropes. The cart is also fitted with staples underneath the shafts to take slats for man draught. Props are attached to the hind part of the cart as well as to the shafts.

A canvass cover and lashing rope are issued with the cart, and a web girth attached to the shafts.

The cart may be fitted in various ways, for instance, as a forge, ambulance, or water cart. The weight complete with forge (wooden) is 11 cwt. 8 lbs., and with cask for water (empty) 7 cwt. 0 lbs.

Mark I. Maltese cart was mounted upon 4′ 2″ wheels, and the cross bars in it were not all of the same length.

Some Maltese (at least so called) carts have been made with movable shafts, that is, shafts attached by bolts to the sides instead of in one piece with them.

CHAPTER V.—AMBULANCE CARRIAGES, &c.

Table.

The following are the carriages special to the army hospital service:—

Nature.	Wheels.									Weight.			Tonnage.
	Class.	Nave.	Diam. of Fore.		Diam. of Hind.		Width of Tire.	Track.					
			ft.	in.	ft.	in.	in.	ft.	in.	cwt.	qrs.	lbs.	tons.
Wagon, ambulance, Mark II.	III.	Wood	4	2	4	2	3	5	2	16	2	0	5·500
Wagon, ambulance, Mark III.	III.	Madras	3	0	4	8	2	5	2	18	0	5	3·625
Cart, medical -	III.	Wood	—		5	0	3	5	2	18	0	0	3·950

Ambulance Wagon. Mark II.

This wagon consists of a body supported on steel side springs, with india-rubber check springs, over a fore and hind carriage. The frame of the body is boarded over and fitted with a low movable head and sides. Each side is formed by an upper and lower longitudinal bar, connected by standards and by rounded rails, and is boarded for a portion of its height on the inner side. The head is made somewhat similarly but lower, and in three pieces hinged together, to adapt it to the angular form of the bottom in front.

Ambulance wagon. Mark II.

The hind carriage is a simple frame bolted to an axletree bed, and pivoted upon the hinder part of the fore carriage.

The fore carriage is similar to that of the O.P. general service transport wagon, and is fitted for draught in the same way.

The interior of the body is divided by movable partitions, one near the front and the other near the rear, and between these by a longitudinal partition down the centre. The front compartment, so formed, serves for the feet of persons sitting on a front seat strapped across between the sides; the long compartments receive each a stretcher, and the hind compartment serves as a seat, a footboard for which is formed in two pieces and hinged to the earbed. This board when not required as a footboard can be turned up and secured as a tailboard. Each seat will take three men. For mounting to the front seat a step ladder is hinged on the near side, which when not in use is strapped along the side of the wagon.

Bale hoops and canvass cover are placed over the body, an extra hoop being hinged to the fore and hind hoops, to hold the cover as a hood over each seat; curtains are also suspended in front and rear to close the interior. A water barrel is carried upon the futchells of the fore carriage, and in the interior of the wagon there are racks for arms, a basket for knapsacks, &c.

Stretchers.

The stretchers for the wagon are each formed of a top and under frame; the former, covered with canvass and fitted with a pillow, is hinged at one end to the latter, and supported over it, at the other end and in the centre upon india-rubber springs. The ends of the lower frame form handles for lifting, and beneath the frame are fitted four small rollers on which the stretcher can easily be pushed into the wagon, the hind partition being for the time removed.

Ambulance Wagon. Mark III.

Ambulance wagon. Mark III.

This wagon carries the same number of persons as the preceding, and in a similar manner, namely, two on stretchers, three on a front seat, and three on the hind part of the wagon. It consists of a fore and hind carriage; the body of the latter is formed by an oak frame boarded with yellow deal, and fitted with low folding head and sides, the frames of which are of oak and the boarding of pine; the sides have also each a top rail of ash. To the hind earbed is attached a folding tailboard of mahogany, to which a footboard of elm is hung by jointed stays. When the tailboard is down it is kept in position by stays underneath, and the footboard can then be used as such by men sitting on the hind part of the bottom of the wagon. The body is attached to its axletree by semi-elliptical springs, and has also a check spring under the centre.

The framework of the fore carriage is of oak formed in the usual manner; the parts are light in scantling, and the splinter bar and fut-



chells are strengthened by plates of iron. It is supported upon three springs, one attached to the centre of the cross bar; the front extremities of the other two, which are side springs, to the outer futchells, as is generally the case, but their hind extremities to the first-mentioned spring, which lies at right angles to them.

The splinter bar is fitted with frame shafts for double or single draught, and with links to take the trace hooks; the fore carriage is also fitted for pole draught. The linch pins of the fore axle are formed each with a plate upon the head to serve as a step, another plate as step being placed on each end of the splinter bar and on each end of the front earbed of the body.

A movable seat of pine, with back of pine, back rail of mahogany, and side rails of iron, is secured across the top rails of the wagon sides in front, the footboard for which is attached by hinged joints to the headboard.

A sliding partition, also of pine, with rail of mahogany, is fitted across the interior of the body towards the rear to serve as a back board for the hind seat.

A locker is formed on each side of the wagon to the front, the one on the off side with partitions for wine, that on the near side for tools and stores. Under the hind part of the wagon there are jointed iron bands in which a corn locker and water tank (for 9·6 gallons) are carried, the former accessible by two lids in the bottom of the wagon, the latter fitted with a leather tube and funnel.

The roof of the wagon consists of an angular frame of ash hinged together along the centre, and supported on rod standards of tubular galvanized iron, which fit into sockets on the sides of the wagon. Galvanized iron hoops are jointed to the front and rear standards for hoods, and the front standards are strengthened by jointed stays. The cover, curtains, and hoods are of canvass waterproofed.

A double screw brake worked by a cranked lever handle is fitted to act upon the hind wheels; a drag shoe is also carried.

The seats are fitted with cushions and leather aprons, and the front seat with a driving box.

A ladder of ash is carried upon the fore carriage, and when required to give access to the fore carriage it is attached to the front of the wagon by loops.

The fittings for the stretchers consist of a long partition down the centre of the body, and four rests with metal crutches. The rests are "fore" and "hind" for each stretcher; they slide in guides on the partition and sides of the wagon. The centre guides are hinged at the rear, so that they can be folded in to admit of the partition or back board for the hind seat being placed. To place a stretcher in the wagon the back board and cushion of the hind seat are removed, the ends of the centre guides turned back, the front rest moved to the rear, and the handles at the foot of the stretcher placed in the crutches. The stretcher is then pushed in until the handles at the head can be placed in the crutches of the hind rest, when the stretcher is pushed home, the ends of the guides folded in, and the back board and cushion replaced. In case of the loss of the rests two crutches are secured by chains to the bottom of the wagon, which can be fitted into sockets for the purpose on the side and partition, and in which the handles of the stretcher can be supported.

Stretchers. The stretchers consist each of a tanned canvass bottom connected to two ash poles, which are kept at the required distance apart by two



jointed galvanized iron rods. The ends of the poles are formed into handles, to which leather stops are attached for the crutches in the wagon; other leather stops are attached to the middle of each pole for the stretcher support. Each stretcher is fitted with four short folding iron legs, and has a pillow tied upon the head by leather thongs.

Medical Cart.

Medical cart.

This is a light cart with hinged sides and movable head and tail boards. The shafts are fixed to the body, which rests upon steel springs over the axletree bed. Upon the near side there is a sliding outrigger for double draught. The cart is fitted with movable ladders at the sides and ends, with bale hoops and canvass cover, and under the hind part with a stop ; there are also fittings for entrenching tools and small stores.

Stretcher Support. Mark I.

Stretcher support. Mark I.

The support consists of a steel axletree with a pair of wheels, a pair of elliptical steel springs with crutches to receive a stretcher, and a pair of folding legs.

The wheels are 3′ 0″ in diameter, with a tire 1″ in width, and have a track of 2′ 7½″. Each is formed of eight steel spokes screwed into a wrought-iron nave and riveted to a tee-iron tire, and is kept in position upon the axletree arm by a thumbscrew. A collar encircled by a washer is fixed to the back of the nave; this, when the wheel is on its arm, is covered by a metal cup fixed to the shoulder of the axletree. The cup has two hooked lips diametrically opposite to each other, and the washer two flanges similarly situated. To allow of the wheel being put upon its arm the flanges must be placed horizontally, and when the wheel is in its place they must be turned vertically in order to bring them under the lips of the cup, and allow of the thumbscrew going into a slot in the flange to receive it.

Each elliptical spring is two leaves thick, and has a clip riveted to the under part, with a stud, split key, and chain to secure it to the axletree, also upon the upper part a galvanized iron crutch. The crutch has a hinged flap by which with a turn-buckle the stretcher is secured; this flap when turned back also acts as a stop to the wheel.

An iron leg is attached to the rear of each spring by a double joint, when not required for use it is turned up and secured to the stretcher by a shackle and hook.

The weight of the stretcher support is 75 lbs.

Litters. Mark II.

Litters. Mark II.

Litters are "near" and "off," and are formed each of a light iron frame with canvass bottoms, and over the head a folding hood. Each litter is attached to the saddle by hanging bars, to which it is secured by a bolt. The hanging bars hook to the saddle and are secured by thumbscrews and a girth, while the litters are steadied by a strap passed round them and the body of the mule. A pillow is secured upon the head of each litter and an apron over the body. The aprons are "near" and "off," Mark II.

When not required for use the litters can each be folded in three, turned up against the mule's side, and retained by a strap.

A pair of litters weigh 93¾ lbs.

Cacolets. Mark II.

Cacolets. Mark II.

A cacolet consists of a light iron-framed seat attached to the saddle by hanging bars to which it is riveted. It is fitted with a guard iron on the outer side, and straps in front and rear to secure a sick or wounded man, also, with a foot rest slung by straps and with a cushion. When not required for use it can be folded against the mule's side.

Cacolets are "near" and "off"; a pair weigh 56 lbs.

Ambulance Barrow.

Ambulance barrow.

The ambulance barrow is the China barrow fitted to take a field stretcher; the latter rests in iron crutches, those in front pinned into the sides, and those in rear attached by indian-rubber springs to supporting bars, by which the head of the stretcher is held sufficiently high when the barrow is lifted by the handles for travelling.

Ambulance Cart.

Ambulance cart.

This is the Maltese cart fitted with two folding stretchers with hoods and covers. The stretchers are supported on two battens hung across the cart, one in front and one in rear, from iron standards by indian-rubber springs.

PART II.—GARRISON CARRIAGES.

CHAPTER I.—PRINCIPLES OF CONSTRUCTION OF GARRISON GUN CARRIAGES.

Essential qualities.

The qualities requisite in a garrison gun carriage may be taken as the following, namely :—

Strength and stability to withstand the shock of discharge.

Facility for working the gun.

Simplicity and durability.

It being assumed that the nature and object of a work in which carriages are placed may sometimes be such as to render it necessary for the carriages to be mounted upon traversing platforms, the qualities just mentioned will best be considered, first with reference to the carriage proper, and second with reference to the platform.

THE GUN CARRIAGE.

The gun carriage.

1. Strength and stability. The remarks made as to the destructive effect of discharge upon a field gun carriage are equally applicable to a garrison gun carriage, and may be summed up by saying that with regard to the horizontal component of the blow of discharge, the recoil should be permitted to be a maximum, and that the height of the axis of the trunnions should be kept at a minimum, while with regard to the vertical component, the whole of that portion of it which is transmitted to the carriage may be assumed to be spent upon the carriage, as the platform upon which the latter stands is usually hard and unyielding.

The principle of having the axis of the trunnions as low as possible is well illustrated, as will hereafter be seen, in Captain Scott's construction of carriage, where the brackets are only sufficiently high to admit of the maximum elevation or depression required for the gun being given, namely, about 15° elevation and 10° depression.

In carriages for the lighter guns, 7″ M.L.R. of 90 cwt. and under, a single plate of wrought iron is found to yield sufficient strength for the bracket, which is kept from buckling by the transoms, which give it rigidity. In carriages for the heavier natures of guns, 7″ M.L.R of $6\frac{1}{2}$ tons and upwards, two plates are required to form the bracket, and these are kept from buckling, not only by the transoms, but by a rigid frame to which they are intimately attached. In such carriages the frame does not yield much strength for the support of the shock of discharge, being simply added, as just mentioned, for the sake of rigidity, and hence in many cases it is now made of cast instead of wrought iron.

The thickness of the bracket plates and the strength of the frame depend not only upon the gun, but upon the height of the bracket, and this furnishes an additional reason for keeping the latter at a minimum.

The width of the frame must be such as to give it the requisite strength in itself, and also, with the plates attached, to furnish sufficient bearing for the trunnion of the gun, as well as to give the bracket a sufficiently wide bearing on the platform or other support. Neglecting increase of weight, &c., the wider the bracket is the better, in the event

of any cross action upon it, and also to give bearings for the spindles of gear. In single-plate carriages, bearings have to be attached both for the trunnions and the gear.

With regard to stability, a garrison gun carriage can conveniently be of such form as to have at least four points of support, between which the points of attachment of the gun to the carriage can lie, and at the same time be sufficiently distant, horizontally, from the rear supporting points, to prevent any tendency in the carriage to overturn on discharge of the gun, and from the front, to prevent any overturning when run up. Plainly, the further apart the front and rear bearing points of the carriage are from each other the greater the stability will be, while the higher the brackets the further apart those points must be. The width from side to side between the bearing points is not required to be great, as there is not much cross action on the carriage, and practically the width required between the brackets to admit the gun is enough for stability.

2. Facility for working the gun. To lay a gun readily there must be facility for moving it in a horizontal as well as in a vertical plane; the latter is now accomplished by means of toothed gear, by which any required power may be obtained. In "sliding" carriages or those mounted upon traversing platforms, the horizontal motion is given to the gun entirely by means of the platform, while in "standing" carriages or those mounted upon ground platforms, where the guns do not usually require much traversing and besides are comparatively light, it is given by cross lifting the rear of the carriage.

In working the gun it is desirable that the carriage should be easily brought back to the firing position, from which it follows that the recoil must be kept within a reasonable limit, though, as we have already seen, the greater it can be allowed to be the better, in order to save the carriage. Practically the recoil is curtailed by the platform having a slight slope to the front, which is given to it to facilitate running up, and by the use of compressors. It is sometimes necessary to keep the recoil within very short limits on account of confined space in the work; with M.L. guns it must, however, always be permitted to be sufficient to allow of the gun being loaded easily.

To facilitate the moving of the carriage and gun from the position of recoil to that of firing, trucks or rollers are added to the carriage; the diameter of these need only be small, as the carriage has not a great distance to move through, and the surface upon which it moves is smooth and hard; further, in standing carriages which necessarily always rest upon their trucks, it would not do to have the diameter of the latter great, as the recoil would thereby be facilitated. The same reasoning applied to the axles of the rollers or trucks shows that there is no necessity to keep them of small diameter, but rather an advantage in having them of large diameter. The front rollers or trucks of a carriage are always of greater diameter than the rear, to compensate in carriages used on ground platforms for the slope of the platform, and make the body of the carriage stand level, and in all carriages because there is a greater weight thrown upon the front than upon the rear trucks, on account of the position of the centre of gravity of the gun with regard to them.

In view of working garrison carriages with facility, they should be constructed as light as consistent with strength, particularly if for use on ground platforms, though in point of absorbing some of the force of recoil weight is of some advantage.

3. Simplicity and durability. These qualities in a gun carriage are undeniably necessary, seeing the nature of work which the carriage has to perform.

The Traversing Platform.

1. Strength and stability. Of necessity, for stability a traversing platform should have four points of support, two in front and two in rear; some platforms have, however, been constructed with but three points of support in order to facilitate their movement. The distance apart of the points of support depend entirely upon the carriage; the width from side to side upon the width of the carriage, and the length from front to rear upon the maximum amount of recoil allowed; the points must always be such, that the centre of gravity of the gun and carriage will fall between them in any possible position of the carriage.

The traversing platform.

With regard to the strength of a platform, the force of discharge communicated through the carriage to the platform is spent upon the latter, partly as a breaking strain across its length, and partly in a tendency to move it to the rear, the relative proportion of the two strains varying, as in the case of the carriage, with the elevation of the gun.

The force tending to move the platform to the rear is resisted by the inertia of the latter, and borne by the pivot and by the flanges of the trucks.

The cross breaking strain must be met by the strength of the sides of the platform; it will be greatest at that portion of the sides which lies immediately under the gun in its first motion of recoil, and hence the cross section of the sides should here be the greatest, and gradually reduced towards the points of support; this is illustrated in the fish-belly form of some platforms.

2. Facility for working the gun. The platform being a supplementary carriage, added for traversing the carriage proper upon, all that is required in it is that it should itself traverse as easily as possible. In this view the diameter of the trucks should be at a maximum consistent with the height allowed to the axis of the trunnions of the gun, the height of the brackets of the carriages being, as already stated, kept at a minimum, and this it will be seen is carried out in Captain Scott's construction of platform; also the diameter of the axles of the trucks should be at a minimum.

The rule by which the height of the axis of the gun is governed is that in the 11″ M.L.R. gun, and higher natures, the gun must be capable, at 5° of depression, of firing over a genouillère 4′ 3″ high, if mounted in a barbette battery, and 3′ 0″ if in a casemate; and that in the 9″ M.L.R. gun, and lower natures, the gun must be able to fire with the same depression over a genouillère 4′ 3″ high if mounted in barbette, and 2′ 6″ if in a casemate.

The diameter of the trucks being, as already stated, kept at a maximum should nevertheless vary in the fore and hind trucks relatively to each other, according to the position of the pivot, and the consequent radii of the racers upon which they have to travel. With regard to the form of the trucks, they should be conical, that is, bevelled on the sole, as they have to travel in a circular path, the amount of the cone depending upon the radius of the racer, and this point is now carried out in the platforms for 10″ M.L.R. guns and upwards. Flanges are necessary to the trucks to keep the platform in its position, but on account of the friction between them and the sides of the racer they are an evil; to reduce the evil to a minimum the hind trucks are now made without a rear flange, the corresponding flange on the front trucks being sufficient to hold the platform.

With heavy platforms mechanical means are necessary for giving them motion in order that they may be traversed quickly, and at the same time be under perfect control. For this purpose toothed gear is

employed, applied to two trucks only in natures under the 12″ of 35 tons, as being sufficient. The largest trucks are those chosen to be placed in gear for gain of power, not only owing to their greater diameter, but, also, because running upon the curve of the greater radius better leverage is afforded for moving the platform, with respect to the pivot as centre.

It is almost unnecessary to add, that with regard to facility of moving the platform, its weight should be a minimum consistent with strength.

3. Simplicity and durability. These qualities, as in the case of the carriage, require no comment.

CHAPTER II.—WOODEN GARRISON GUN CARRIAGES AND TRAVERSING PLATFORMS.

Garrison gun carriages are of three descriptions; namely, common standing, rear chock, and sliding. In either description the carriages for the different natures of guns differ only in dimensions.

Sliding carriages are either casemate or dwarf, which differ from each other only in the height of the brackets.

The following are the principal wood garrison carriages in the service:—

Table.

Nature.	Standing.		Rear Chock.		Sliding.			
					Casemate.		Dwarf.	
	Weight.	Tonnage.	Weight.	Tonnage.	Weight.	Tonnage.	Weight.	Tonnage.
	cwts.	tons.	cwts.	tons.	cwts.	tons.	cwts.	tons.
7″ B.L.R. of 72 cwt. -	—	—	—	—	15	1·45	16½	1·71
64-pr. M.L.R. of 64 cwt.	14½	1·91	—	—	—	—	—	—
64-pr. B.L.R. of 61 cwt.	11	1·64	—	—	—	—	13½	1·80
40-pr. B.L.R. of 35 cwt.	13¾	1·80	—	—	10½	1·88	11½	1·68
10″ S.B. of 87 cwt. -	—	—	19¼	2·34	15¼	1·65	16¼	1·28
8″ S.B. of 65 cwt. -	14½	1·98	14	2	13½	1·59	14¾	1·28
68-pr. S.B. of 95 cwt. -	—	—	19¼	2·34	15¼	1·65	16¼	1·85
32-pr. S.B., 56 or 58 cwt.	14¾	1·94	13½	1·79	—	—	14	1·50

M.L.R. guns converted from S.B. take the same carriages after as before conversion.

I. Standing Carriages.

Standing carriages. (See R.C.D. photo-lithographs, 62 and 63.) Construction.

A standing carriage consists of two brackets, two axletrees, a transom, and four trucks.

The brackets are of oak or teak in one or two pieces; trunnion holes for the gun and steps to serve as fulcra for handspikes in elevating, are cut in them. To prevent the wood splitting, in each bracket, at each side of the trunnion hole, there is a horizontal rivet. If a bracket is made in two pieces, the latter are connected by dowels and a joint bolt, which passes down from the top step of the carriage, and is nutted beneath. In carriages for B L.R. guns, except the 40-pr., the upper steps are cut away.

The transom, of the same wood as the brackets, is housed into the latter and secured by a horizontal rivet.

The axletrees are of oak,* the body rectangular and the arms cylindrical, each is housed into the brackets. The front axle is secured by two axletree bands and four boss-headed bolts keyed beneath; the rear axle by four rivets with countersunk heads. An iron band is shrunk on to the end of each arm, and a clout plate nailed beneath.

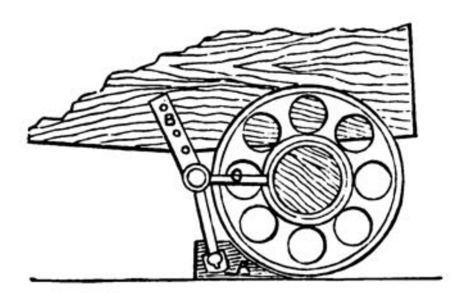
A horizontal tie rivet passes through the lower part of the brackets.

The trucks are of cast iron, the front 19″ and the rear 16″ in diameter, they are secured on the arms by iron linch-pins.

Fittings. The fittings of the carriage are, an eye bolt on each side, a square metal nut for the elevating screw bolted in the rear axle, a bed staple on the back of the transom with pin to secure the stool bed, and a leather loop for the priming wires on the right bracket.

Articles belonging to. The articles belonging to the carriage are "large" and "small" quoins of sabicu, a stool bed of wrought iron, and elevating screw of the ratchet head and lever pattern. The stool bed has a long groove in its under surface to take the head of the screw.

Allen's brake. To check the recoil when violent guns, such as 64-pr. M.L. or B.L.R. are mounted, Allen's brake is applied to each front truck. It consists of a wooden wedge A, shod with iron, attached to the bracket immediately in rear of the truck by jointed bars of iron, the upper of which,



B, are bolted to the bracket, while from the joint another bar, C, passes horizontally through the axletree arm, forming the linch-pin. The wedge rests upon the ground in rear of the truck, following it as the carriage is run up, but on recoil the truck overtakes and rides upon the wedge. A rope lanyard is attached to the wedge, and an iron cleat upon the side of the carriage, so that, if it is wished not to use the brake, the wedge can be secured so as not to come into action on recoil.

Depression carriages. (See R.C.D. photo-lithograph, 66.) Depression carriages are a species of standing carriage used with guns mounted at great elevations. They are fitted with capsquares, and a movable block across the second steps in which the elevating screw is held, and thus great depression can be given to the gun; the front part of the brackets is also sloped away.

II. Rear Chock Carriages.

Rear chock carriages. Construction. Rear chock carriages are used for the more violent guns. They are similar in general construction to standing carriages, but instead of a rear axle and trucks have a chock or block of sabicu or African oak.

Fittings. The carriage fittings are an eye bolt on each bracket and one on the rear of the chock; on the chock there is also, in rear, a handspike iron to take the roller handspike, and on the upper surface a metal socket for

* Of African oak for converted rifled guns. On account, however, of the scarcity of African oak it is proposed in these to substitute English oak strengthened by tee iron.

the elevating nut: on the right bracket there is the usual leather loop for the priming wires.

Articles belonging to. The articles belonging to the carriage are quoins, stool bed, and elevating screw, as for the standing carriage, except that the latter has an oscillating instead of a fixed nut, and consequently the groove in the under side of the stool bed is not elongated.

Rear chock carriages are fitted with Allen's brake when necessary.

III. Sliding Carriages.

Sliding carriages. (See R.C.D. photo-lithographs, 60, 60A, 60B.) Construction. Sliding carriages differ in construction from standing carriages, in having sabicu or African oak blocks, instead of axletrees and trucks, to take the bearing on the platform. The blocks are secured in the brackets by bolts in the same manner as axletrees, the nuts of which are countersunk. Under the bearing surfaces of the front block, metal friction plates are fixed to prevent wear of the block, and a guiding piece projects beneath each block to guide the carriage as it slides upon its platform. Two 8″ metal rollers to facilitate running up are secured in wrought-iron flanges bolted upon the front of the front block. (In older patterns these rollers are held, each, in iron cheek plates bolted to the brackets: the new arrangement has the advantage of making the track of the rollers independent of the width between the brackets.) An eye and notch for a pawl is fixed in the rear of each bracket to take a roller handspike for running up. When by the roller handspikes the rear of the carriage is raised 2″ the front rollers should come into play, and when the carriage rests upon its blocks the front rollers should have a clearance of $\frac{3}{16}$″.

Fittings. The fittings of the carriage are two eye bolts for tackle on each bracket, an eye plate on the rear block for the preventor rope, or for the pintail of the transporting dilly, a hole through the front block to receive the transporting axle, a socket for the elevating screw, a loop for the priming wires, and in the 7″ B.L.R., a loop for the tin cup extractor.

Articles belonging to. The elevating screw, &c. is the same as for rear chock carriages.

The upper side steps are cut away in carriages for B.L.R. guns, except the 40-pr., as in standing carriages.

IV. Traversing Platforms.

Traversing platforms. Traversing platforms are either casemate or dwarf, corresponding to sliding carriages; in both the upper part or frame is the same, the difference being in the height to which the frame is raised. The same platform, dwarf or casemate, takes all natures of wood sliding carriages.

The casemate platform weighs 27 cwts., the dwarf 33¾ cwts., while the tonnage of both is 2·62 tons.

Casemate. (See R.C.D. photo-lithograph, 60A.) The platform is made entirely of teak, and if casemate consists of the following parts, namely, two sides with cheeks, three transoms, one head block, four flanges, and four trucks.

The sides 16′ × 1′ × 1′, with the outer edges bevelled off, are placed 21″ apart; their ends are hooped and the upper surfaces shod with iron plates. The cheeks are nailed to the sides to give sufficient bearing for the flanged feet.

The transoms are mortised into the sides and secured by tie bolts, two through the rear, one through the centre and one through the front transom, and one at the back of the front transom.

The head block is dovetailed between the sides over the front transom, to which it is bolted, to form a stop for the carriage when run up.

Four bolt holes are bored through the sides to receive the bolts of the flanged feet, and behind the rear holes are nailed two half-moon pieces to form bearings for the feet and bring the platform to the required slope of 5°.

The front flanges are of metal, the rear of cast iron, each secured by a single bolt, which for the front is 8″ long and for the rear $13\frac{1}{2}$″. The front flanges are fitted with two small plates of iron over the axle bearings, which pivot on studs and enable the roller to be removed and cleaned when necessary.

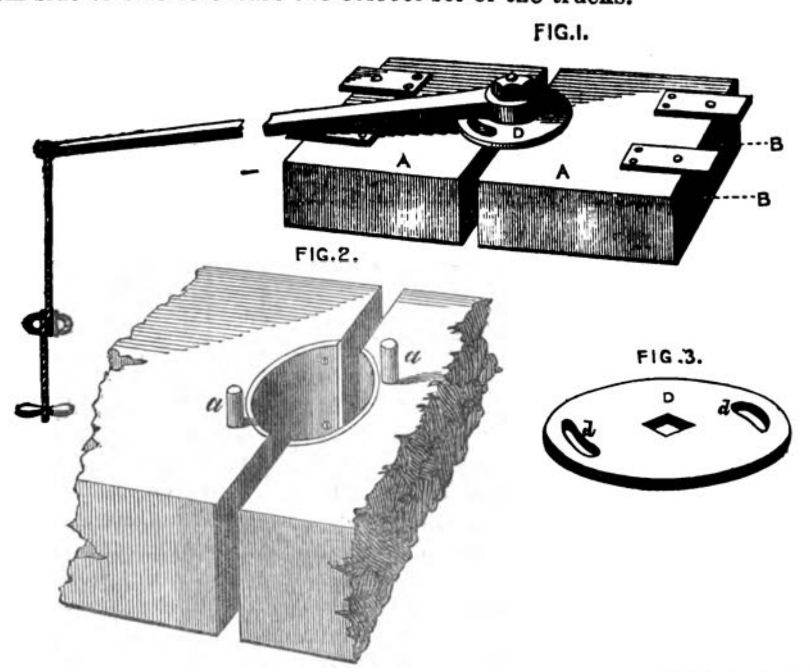
The trucks are of wrought iron, hollow soled; the front $4\frac{7}{8}$″ in diameter and the rear 12″; the front are formed in one piece with their axles.

The fittings of the platform are; four battens between the rear and centre transoms for men to stand on, a bollard for preventor rope on the inner side of the left side, iron stops to receive the carriage on recoil, 15″ from the ends of the sides, eyebolts for tackle, two on each side, a bent plate between the sides in rear, with hole for the pintail of the transporting dilly, and axletree bands for the transporting axle.

Dwarf. See R.C.D. photo-lithographs, 60, 60B.)

The dwarf platform differs from the casemate in having a block which fits under the sides in rear, beneath the half-moon pieces, and takes the bearing of the flanges instead of the latter, the bolts of the flanges passing through it. Two dowels project from it and enter the rear transom. The bolts of the rear flanges are 25″ and of the front $13\frac{1}{2}$″ (i.e. the same as the rear of the casemate): the front and rear trucks are 12″ in diameter (the same as the rear in the casemate). The platform is also fitted with side steps, a long one on the right and a short on the left.

A casemate platform is readily converted into a dwarf, or vice versâ. The trucks are also readily altered in position from one pivot to suit any other, by simply loosening the nuts of the bolts of the flanges, setting the trucks to the new radii, and then tightening the nuts again; before the latter is done, however, the platform should be traversed from side to side to ensure the correct set of the trucks.



The "wooden" compressor.

To check the recoil of the 7″ B.L.R., 64-pr. or 80-pr. M.L.R., 10″, 8″, or 68-pr. S.B., when mounted on a sliding carriage, the compressor

known as the "wooden" compressor is used. It is made of three different sizes, namely; 1′ 5″ long for the 7″; 2′ 4¼″ for the 10″ and 68-pr., and 1′ 10″ for the remaining gun carriages.

The compressor consists of two cheeks, A, A, of elm, held together by two guide bolts, B, B, in such a manner that they fit tightly in one cheek but slide easily in and out of the other, being prevented sliding beyond certain limits by nuts. An iron eccentric is fitted between the cheeks in metal bearings, through which a square bolt passes from the under side: over the bolt resting upon the upper surfaces of the cheeks an iron disc D is placed, and above it again a lever handle, with fall and toggle, is nutted on the bolt. In the iron disc are two slotted holes *d*, *d*, through which a small iron stud *a*, on each cheek projects. Two short iron plates project on each side of the compressor and serve to support it as it lies between the sides of the platform beneath the carriage: its lever is on the right, and when drawn to the rear, by means of the eccentric, presses the sides of the compressor against the sides of the platform, fixing it therefore more or less to the latter: the carriage however to recoil must carry the compressor with it, and therefore the recoil is checked. To remove the compression for running up, the lever is drawn to the front, when the slots in its iron disc working on the studs in the cheeks bring the latter together and free of the platform.

If from wear of the outer sides of the cheeks the lever fouls the rear block of the carriage before the required amount of compression is obtained, the lever must be cranked. If the sides are so worn as to be flush with the guide bolts, the metal bearings must be removed and pieces of leather packed between them and the woodwork.

When not in use the compressor should be removed from the platform to store.

CHAPTER III.—MORTAR BEDS.

Mortar beds for land service are as follows:—

Table.

Nature.	Weight.	Tonnage.
	cwt.	tons.
13″ cast-iron bed - -	32¾	1·22
10″ „ - -	17¾	·56
8″ „ - -	8¾	·29
5½″ wood bed - - -	1	·11
4⅖″ „ - - -	¾	·04

Cast-iron beds.

The beds for the heavier natures of mortars are of cast iron, and consist of two brackets and two transoms, held together by rivets, five in the 13″ bed, four in the 10″, and three in the 8″.

In the 13″ and 10″ bed two of the rivets project beyond the brackets on either side to form running-up bolts; on the 8″ bed running-up bolts are cast on the brackets. In all natures a horn, for a handspike to take a purchase against for traversing, is formed on each extremity of the bracket.

The capsquares are of wrought iron and fit with clips over the trunnion holes in slots on the bed, where they are secured by wrought-iron pins.



Each bed has a wood quoin fitted over the front transom to give the mortar an elevation of 45°, or in some cases of 75°.

To put a bed issued in pieces together, the parts are first screwed together and, the correct width between the brackets being arranged by packing pieces under the transoms, if necessary, then riveted together. The highest rivet in rear of the trunnions should first be riveted and next the foremost. The interstices between the brackets, transoms, and bolts are then filled in with molten lead.

Wood beds.

The beds for the two smaller natures of mortars are formed, each, of a block of sabicu or African oak, hollowed out to receive the breech of the mortar, and fitted with capsquares, a quoin, and rope handles.

S.S. wood beds, adapted to L.S. (See R.C.D. photolithograph, 78.)

The 13″ and 10″ S.S. mortar beds have sometimes been employed for L.S., in which case they are mounted with their octagon decks on special ground platforms, india-rubber rings being placed between, and the whole secured together by a central bolt.

CHAPTER IV.—WROUGHT-IRON STANDING OR REAR CHOCK GUN CARRIAGES.

There are two natures of wrought-iron standing gun carriages, identical in construction and interchangeable in all their parts, excepting the transom bolts.

They are denoted respectively No. 1 and No. 2.

Table.

Nature.	Weight.	Tonnage.	Width between Brackets.	Height of Axis of Trunnion, (about)	Trucks. Diam. of Fore.	Diam. of Hind.	Track of Fore & Hind.	Guns which the Carriage will mount.
	cwts. qrs. lbs.	tons.	in.	in.	in.	in.	in.	
No. 1.	17 1 0	1·25	26¼	39½	20	18	54	64-pr. M. L. R.* Mark I. or B.L.R. 8-in. S.B., 65 or 54 cwt.
No. 2.	17 1 0	1·25	22¼	39½	20	18	54	40-pr. B.L.R. 32-pr. S.B., 58 or 56 cwt.

* The carriage will also take Marks II. and III. though they do not fit it accurately.

No. 1 Carriage. Mark I.

No. 1 carriage. Construction. (See R.C.D. photo-lithograph, 64.)

The body of the carriage consists of two skeleton brackets connected by a fore and hind axletree and by two transom bolts.

Each bracket is formed of three double stays of plate iron bolted at their lower ends to a tie piece of tee iron, and at their upper to a semicircular piece, also of tee iron, which forms the trunnion hole.

The body of each axletree is of girder iron, the arms being bolted to it. Recesses are formed for the axletrees in the brackets by bending down the extremities of the tie pieces and bolting knees underneath the latter; the fore axle is placed with its web vertical, the hind with its web horizontal, and each is bolted in its position. The transom bolts pass, one through the front, and the other through the middle stays of the brackets.

The trucks are of elm, shod with a ring tire and bouched with metal; they are kept on the arms by linch-pins.



Fittings. Two iron steps are bolted upon the hind stay of each bracket to serve as fulcra for handspikes, when the latter are used in elevating.

The body of the hind axle is filled in with wood between the web and the flanges, and recessed to receive the elevating screw nut.

The second transom bolt is shaped to receive the front end of the stool bed, and a pin is chained to it for securing the latter.

Beneath the hind axletree two blocks of sabicu are bolted, so that by removing the hind trucks the carriage can be converted into a "rear chock" carriage, while behind the axle a handspike iron is attached for the roller handspike then required.

To reduce the size of the trunnion holes and the distance between them, and thereby adapt the carriage, when necessary, to take the 8-inch S.B. guns, there is a semicircular plate, with projecting shoulder, to fit each trunnion hole. The plates are each stamped "8 inch."

Marking. Upon the upper surface of the hind axletree are stamped the natures of guns for which the carriage is intended, the mark, date of manufacture, and weight.

Articles belonging to. The elevating screw is the "ratchet head and lever," already described in Part I.; it has a square nut, which is let into and bolted in the hind axle.

The stool bed is of wrought iron 2′ 8½″ long from the centre of the pin hole in front to the centre of the groove in rear.

The quoins, "large" and "hand," are of sabicu, the former plated where it takes the bearing of the breech of the gun.

Cast-iron trucks are issued to replace the wooden trucks when the carriage is not in use, in order that the wooden may be placed in store and protected from the effects of climate.

No. 2 Carriage. Mark I.

No. 2 carriage. Construction. This carriage differs from No. 1 only in having the brackets placed 4″ nearer to each other, the transom bolts being consequently that amount shorter than those of No. 1 carriage. The same axletrees serve for either carriage, but require fresh bolt holes to be drilled in them to suit the altered position of the brackets.

Fittings. As No. 2 carriage is intended for different guns to No. 1, its trunnion hole fitments are necessarily different to those of the latter carriage, thus,—

To make the carriage suitable for the 40-pr. B.L.R. gun there are trunnion plates similar to those for the 8-inch S.B. in No. 1 carriage.

To adapt the carriage for the 32-pr. S.B. of 58 cwt. there are trunnion plates without a projecting shoulder, while for the 32-pr. S.B. of 56 cwt., in addition to these latter, there are collars to place over the trunnions of the gun.

All the above fitments are marked with the nature of gun with which they are to be used.

CHAPTER V.—WROUGHT-IRON "SLIDING" GUN CARRIAGES, "SINGLE-PLATE" CONSTRUCTION.

Remarks. The first wrought-iron sliding carriages manufactured were made on what is known as the "single-plate" construction. This term was applied to it from the bracket being formed by one plate attached to a frame, instead of, as afterwards, in the construction known as the "double-plate," by two plates, one on each side of a frame.

Single-plate carriages have been made of two different patterns, the first, on the same plan as wooden sliding carriages, viz., the brackets connected by a block in front and in rear; the second with the brackets standing upon a plate which united them throughout their length.

Of the first pattern "casemate" and "dwarf" carriages were manufactured for the 7″ and 9″ M.L.R. guns, and of the second pattern "casemate" carriages for the 7″, 9″, and 12″ M.L.R. guns, and also "dwarf" for the 7″. In each instance the casemate carriage served for sea service, but with fittings more or less different to the fittings for land service.

In the following table the patterns of each nature are not shown separately, as in weight they are almost identical.

Table.

Nature.	Weight.	Tonnage.	Diameter of Rollers.	
			Front.	Rear.
	cwt. qrs.	tons.	in.	in.
7″ M.L.R. casemate - -	27 3	1·72	10	6
„ dwarf - -	29 0	1·77	10	6
9″ M.L.R. casemate -	37 0	2·26	12	8
„ dwarf - -	39 0	2·875	12	8
12″ or 13″ M.L.R. casemate -	56 2	3·92	12	8

PATTERN I. SINGLE-PLATE CARRIAGES.

Pattern I. Single-plate carriages.

Before many of these carriages were issued they were found to be insufficiently rigid in construction, and therefore the remainder before issue were strengthened, some minor improvements being at the same time made in the gear connected with them. Such strengthened carriages will be noticed further on under the head of "Pattern I. strengthened."

All Pattern I. carriages for land service were fitted with the compressor, known as the "American," to check the recoil.

THE 7″ M.L.R. CASEMATE GUN CARRIAGE.

7″ M.L.R. casemate carriage. Construction.

The principal parts of the carriage are the brackets, front block, rear block, and transom.

Each bracket is formed of a frame of angle iron in two parts, strengthened by a diagonal stay of tee iron. On the outside of the frame a plate of iron is riveted, the latter being of the same shape as the frame, except between the positions of the blocks, where it is made to project beyond the frame.

The blocks are each formed by a frame of angle iron, over which plate iron is riveted. The rear or hind block is bent downwards at the centre, while the front block is flat throughout.

The transom is of plate iron riveted along the sides and lower edge to a frame of angle iron.

The blocks are bolted underneath the bracket frames connecting the latter in front and rear. The transom rests upon the front block between the brackets, and is bolted to the latter as well as to the block.

Pieces of angle iron, termed "guide plates," to guide the carriage when in motion on its platform, are bolted across each block underneath; the spaces between the guide plates and extremities of the blocks, as well as the spaces under the brackets between the blocks, are filled in with sabicu to give flat bearing surfaces for the carriage to rest upon

the platform. On the pieces of sabicu in the front block small metal friction plates are fitted.

Beneath the front and rear extremity of each bracket a flanged foot is bolted to receive a metal roller. The axles of the rear rollers are eccentric, and rest in movable metal bearings in the flanged feet. To bring each roller into, or throw it out, of play, a long iron lever is secured by a nut on the outer end of its axle.

Both front and rear rollers are cast with a larger boss upon the inner than upon the outer side, in order that their track may be such that the carriage can run upon the same platform as the 9″ carriage, though the latter carriage is of greater width between the brackets.

Fittings.

To hold the iron lever, by which each rear roller is worked, and so prevent the latter coming into action during the recoil, a catch is bolted upon the upper surface of each bracket.

A slotted metal guide plate is bolted down the inside of each bracket, for the elevating arc to work in ; the latter is of wrought iron (at first of metal), and is rigidly attached to the gun. The arc is moved as required by a pinion which gears in it ; the spindle of this pinion passes through the bracket, and has a spur wheel upon its outer extremity, which is moved by a pinion with large hand wheel. The latter can be clamped as desired by a jamming lever on its spindle. The bearings of the spindles in the brackets are of metal.

The trunnion holes are fitted with metal bearings or trunnion plates, and with capsquares.

A metal socket is bolted to each bracket to take the breeching rope, which is required when the carriage is used for sea service.

A loop for the preventor rope is bolted to the hind block, and a loop for tackle is formed in each end of the same block.

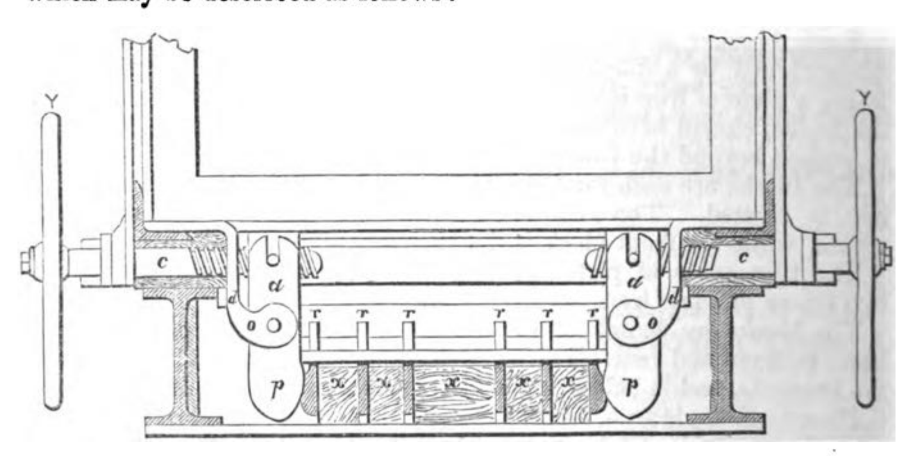
In case of the failure of the eccentric rollers a socket to take the bearing of a roller handspike is bolted under the rear end of each bracket.

A loop to hold the priming wires is attached to the right bracket.

A slotted piece of angle iron is bolted along the inner side of each block to receive and support the compressor plates, while an iron bracket for a rocking lever and a metal bearing for a screw shaft is attached to each side of the carriage.

The compressor "American."

As already stated, the compressor is that known as the "American," which may be described as follows :—



Six plates of iron *r*, *r*, *r*, are suspended between the blocks of the carriage, being strung upon pins which rest on the slotted angle plates attached to the blocks. The plates hang down against five wooden

baulks *x*, *x*, *x*, placed longitudinally on the platform, so that as the carriage recoils the surfaces of the plates slide along the baulks. The surfaces in contact are rough; and therefore resistance to motion or "friction" is set up, and the recoil is thereby checked. The amount which the recoil will be checked will be proportional to the amount of the friction developed, and this again to the force with which the plates press against the baulks. To admit of the pressure being varied at will, the centre baulk is fixed on the platform, while the outer ones, as well as the plates on the carriage, are capable of certain side motion. Outside each outer plate a rocking lever is pivoted to the carriage, its lower arm, *p*, bearing against the plate, and its upper arm, *a*, which is slotted, containing a metal nut. From the side of the carriage a screw shaft, *c*, passes through the nut. The shaft is turned by a large hand wheel, Y, outside the bracket, and according as it is worked it will draw the upper arm of the rocking lever towards, or push it from, the side of the carriage, thereby causing the lower arm to press the plates and movable baulks, on that side, against the centre baulk or to relieve the pressure. It is evident that it is necessary with this compressor to put the compression on at both sides of the carriage each time before firing, and to relieve it before running up.

The 7″ M.L.R. Dwarf Gun Carriage.

7″ M.L.R. dwarf carriage.

This carriage differs from the casemate carriage only in having brackets of greater height, and in not being fitted with capsquares or for a breeching rope.

The 9″ M.L.R. Casemate Gun Carriage.

9″ M.L.R. casemate carriage.

Is similar to the 7″ casemate carriage, but the rollers are cast with the larger boss upon the outer instead of the inner side.

The 9″ M.L.R. Dwarf Gun Carriage.

9″ M.L.R. dwarf carriage.

Differs from the 9″ casemate carriage in the same manner that the 7″ dwarf differs from the 7″ casemate.

Pattern I. Single-plate Carriages, Strengthened.

Pattern I. Single-plate carriages strengthened.

In order to strengthen the first pattern carriages of the single-plate construction the following alterations and additions were made in them:—

Construction.

The two parts of the angle frame of the brackets were more firmly united by iron knees at their junctions, and the connexion of each bracket to the rear block was strengthened by a knee stay.

The sabicu filling-in pieces beneath the brackets and blocks and the angle guides were removed and replaced, on each side, by a piece of tee iron extending from block to block. The web of the tee iron was bolted to the bracket and blocks, and took the bearing on the platform, while the tee being turned to the inside, the lower portion of it, formed the guide.

Additional rigidity was given to the flanged feet by leading short iron stays from them to the brackets.

Fittings.

At the same time the following improvements were made in the fittings and gear; namely,—

The slotted guide plates for the elevating arcs were removed and the elevating gear was altered to that known as the "capstan head" gear, which will hereafter be described for the double-plate carriages.

The long iron levers to work the rear rollers were removed, and sockets to receive iron-pointed levers (as in the double-plate carriages)

substituted for them. The sockets were placed on the outer ends of the axles, and stops formed on the flanged feet against which they could bear in the recoil, and so prevent the rear rollers coming into play. To secure the rollers in the flanged feet a key was added to each foot.

Front loops or eyes were fixed upon the front block, a stud substituted for the hook to take the preventor rope upon the rear block, and buffer blocks of wood attached to the transom.

Pattern II. Single-plate Carriages.

Pattern II. Single-plate carriages.

Construction.

Pattern II., single-plate carriages differ in construction from Pattern I. in having the brackets connected by a plate, termed the "bottom plate," instead of by blocks. This plate is bolted to the under sides of the bracket frames and to the transom and knee stays, packing pieces being inserted where necessary; the centre of the plate is slotted for the compressor plates, and across it, just in rear of the slot, an angle stay of iron is riveted to give it sufficient strength, and also to act as a stop or bearing for the compressor plates. Guide plates of angle iron are riveted along the under surface of the bottom plate, the rear extremities of which are formed into stops to meet the stops of the platform on recoil. Blocks of elm are bolted upon the front of the front transom to act as stops in running up.

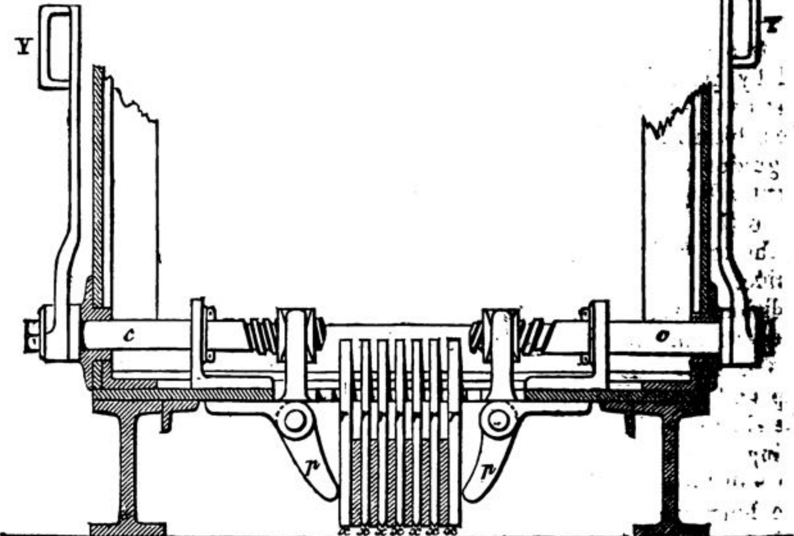
The 12″ carriage differed slightly in its construction from the lower natures in having a second transom instead of knee stays in rear to support the brackets.

Fittings.

The "capstan head" elevating gear is used with the second pattern single-plate carriages, and they are fitted with the compressor known as the "Elswick compressor for single-plate carriages," which is, however, replaced by the hydraulic buffer when a carriage is returned for repair to the Department.

The compressor, "E.O.C. for single-plate carriages."

In principle the compressor is the same as the American, but is so arranged that compression before firing is put on upon one side only of the carriage, while upon the other side the amount of the compression put on can be adjusted to any required degree. The compressor may be briefly described as follows :—



* Six bars of plate iron, *x, x, x*, all of which are movable, take the place of the baulks of the American compressor on the platform.

* The plates, *r, r, r*, seven in number, are shorter and of different shape to those of the latter compressor; they hang through the opening in the bottom plate, and rest in front upon the angle iron of the transom, and in rear upon a supporting bar which is laid across the bottom plate, and, when the plates are in position, is secured by two stops. The plates and bars are compressed together by rocking levers, *p, p*, worked by screw shafts, as in the American compressor, but the shafts, *c, c*, are moved by levers, Y, Y, instead of by hand wheels. The screws on the shafts are of different pitch, that on the right, which is called the compressor shaft, is quicker than that on the left, which is called the adjusting shaft. The levers work each along an arc riveted to the bracket of the carriage, the adjusting lever of iron can be keyed in any position on its arc, and the compressing lever of steel, when the compression is on, is caught under a projection on its arc. By pushing down the compressing lever under its catch the whole of the plates and bars are jammed by the right or compressing rocking lever against the left or adjusting rocking lever, the position of which is adjusted by its lever according to the amount of compression required. The compressor is made self-acting by extending the lower end of the lever so that, on recoil, it will trip against a piece of iron fitted on the platform, and thereby throw the upper part of the lever down into the compressing position. An elastic pad is fitted on the bracket of the carriage to receive and stop the compressor lever when it is thrown down.

CHAPTER VI.—WROUGHT-IRON PLATFORMS FOR SINGLE-PLATE CARRIAGES.

Remarks.

The platforms for single-plate carriages have been made "casemate" and "dwarf," the former for "A" pivot, the latter for "A" or "D."

The same platform served for the 7″ or 9″ carriage, but being found weak had to be strengthened for the latter.

Table.

Nature.	Weight.		Tonnage.	Width between Sides.		Length.	Diameter of Trucks.		Height to Axis of Gun, run up.		Slope of Platform.
							Front.	Hind.			
	cwts.	qrs.	tons.	ft.	in.	ft.	in.	in.	ft.	in.	°
7″ M.L.R. casemate	55	2	3·975	2	10½	15	6	10½	4	1	5
" dwarf -	69	2	3·475	"		"	10½	15½	5	8½	"
9″ M.L.R. casemate	55	2	3·975	"		"	6	10½	4	1½	"
" dwarf -	69	2	3·475	"		"	10½	15½	5	9	"
12″ or 13″ M.L.R. casemate.	80	1	5·000	4	6½	"	7½	10½	4	11½	"

Construction.

The general construction of these platforms is similar to that of the platforms for double-plate carriages to be hereafter described, from which they mainly differ in having trucks of smaller diameter, and consequently longer flanged feet to raise the platform to the necessary height.

Fittings.

The platforms issued for the first pattern single-plate carriages, viz., 7″ or 9″, were fitted for the American compressor by having a baulk of

---

* In the 12″ there are eight bars and nine plates.

sabicu bolted longitudinally down the centre, and on either side of this two others supported on bolts, passing across the platform, through their ends, on which they could move towards or from the centre baulk.

The platforms issued for the second pattern single-plate carriages were fitted for the Elswick compressor by having bars of plate iron, supported by pins through their ends, down the centre of the platform, in the same manner as the baulks for the American compressor, but all movable. To prevent the bars from closing too much upon each other iron collars or rings were strung upon the pins between them. The pins were supported in brackets, and secured by split keys; the front bracket was bolted to the front transom of the platform, and the rear bracket to a bent plate fitted between the sides.

As already explained, to make the compressor self-acting, a steeled piece of iron termed a "tripper" was pivoted on a spindle projecting form a bracket bolted to the right side of the platform; a stop was formed on the bracket for the tripper to bear against when called into action.

Some of the first issued platforms were fitted to take a round transporting axle instead of square, as now adopted for iron platforms.

Platforms for single-plate carriages, when returned to R.C.D., are converted to take the hydraulic buffer, and otherwise brought up to date.

CHAPTER VII. — WROUGHT-IRON "SLIDING" GUN CARRIAGES "DOUBLE-PLATE" CONSTRUCTION.

Remarks.

Of double-plate carriages for land service there are two patterns, differing very slightly from each other; they are known as the Elswick pattern and the Royal Carriage Department pattern. Of the former a few 9″ carriages only have been made, and no more will be constructed.

There is also a third pattern, approved for future manufacture for the 10″ M.L.R. gun, known as Scott's.

Table.

Nature.	Weight (with Gear).		Tonnage.	Diameter of Rollers.		Distance between Guides (outside to outside).	Brackets.	
				Front.	Rear.		Height to Axis of Trunnions.	Distance between.
	cwts.	qrs.	tons.	in.	in.	in.	in.	in.
7″ M.L.R. of 7 tons, fitted for E.O.C. compressor.	30	3	1·700	10	6	34·46875	31·125	35·625
7″ M.L.R. of 7 tons, fitted for buffer.	27	1	1·975	"	"	"	"	"
9″ M.L.R. of 12 tons, fitted for E.O.C. compressor.	44	2	2·600	12	8	41·96875	31·500	42·1875
9″ M.L.R. of 12 tons, fitted for buffer, O.P. elevating gear.	40	0	3·050	"	"	"	"	"
9″ M.L.R. of 12 tons, fitted for buffer, N.P. elevating gear.	40	1	3·114	"	"	"	"	"
9″ M.L.R. of 12 tons, Elswick pattern, fitted for E.O.C. compressor.	—		—	10	8	"	"	"

Nature.	Weight (with Gear).		Ton-nage.	Diameter of Rollers.		Distance between Guides (outside to outside).	Brackets.	
				Front.	Rear.		Height to Axis of Trunnions.	Distance between.
	cwts.	qrs.	tons.	in.	in.	in.	in.	in.
9″ M.L.R. of 12 tons, Elswick pattern, fitted for buffer.	35	3	2·817	10	8	41·96875	31·5	42·1875
10″ M.L.R. of 18 tons, fitted for buffer (high).	51	1	3·747	12	8	46·96875	33·5	47·700
10″ M.L.R. of 18 tons, Scott's pattern (low).	67	0	4·776	13	8	49·46875	23·0	49·500
11″ or 12″ M.L.R. of 25 tons, fitted for E.O.C. compressor, O.P. elevating gear.	68	2	4·675	12	8	55·96875	41·0	57·25
11″ or 12″ M.L.R. of 25 tons, fitted for buffer, O.P. elevating gear.	64	0	5·225	"	"	"	"	"
11″ or 12″ M.L.R of 25 tons, fitted for buffer, N.P. elevating gear.	67	0	"	"	"	"	"	"
*12″ M.L.R. of 35 tons, Scott's pattern.	99	0	—	13	12	59·2187	36·75	59·25
†10″ M.L.R. howitzer of 6 tons.	‡53	0	—	10	6	41·0000	32·00	34·562

* Experimental. † Designed only. ‡ Estimated.

In the double-plate carriages the distinction of "casemate" and "dwarf" does not exist, the same carriage serving for either a casemate or an open battery.

Of the R.C.D. pattern carriages the different natures are alike in their general construction, but in the elevating and other gear they are not so; nor even are all the carriages of the same nature identical in this respect; for example, the carriages first constructed, namely, 7″, 9″, and 12″, had the capstan head elevating arrangement, whereas this mode of elevating is now retained for the 7″ only, while all the higher natures are fitted with the endless screw and worm wheel gear.

The 7″ and 9″ carriages are used for sea as well as for land service, but when so used, as will hereafter be seen, differ very considerably in their fittings.

Double-plate carriages fitted for the Elswick compressor, namely, 7″, 9″, and 12″, first issued, when returned to R.C.D. for repair, are altered to take the hydraulic buffer instead of the compressor. The alteration consists simply in filling in the opening in the bottom plate of the carriage, and in attaching the usual fittings for the buffer. The opening is filled by a plate of iron cut to its form riveted to another plate which lies over the slot, and which in turn is riveted to the bottom plate.

7″ M.L.R. of 7 Tons Carriage. Mark I.

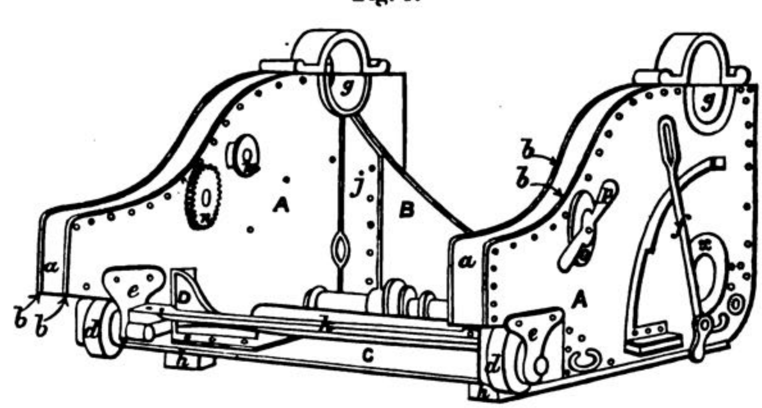
7″ M.L.R. of 7 tons carriage, Mark I. (See

This carriage is formed by two brackets A, A, connected by a bottom plate C, and transom B, and strengthened by two stays D, D.

B.C.D. photo-lithograph, 61B.)
Construction.

As the name "double-plate" implies, each bracket A is made of a frame *a*, to either side of which a plate *b*, *b*, is riveted. The frame is

Fig. 1.



of bar iron $3\frac{1}{2}''$ wide, forged to the required form and planed on each side; a packing piece also of bar iron is fitted vertically between the sides of the frame at the position of the transom. The plates are each $\frac{3}{8}''$ in thickness and are riveted to the frame, the surfaces being first coated with Pulford's black; they correspond to the latter in general form, but project beyond it in front and rear to form recesses for the carriage rollers. The top and under surface of each bracket is planed; when the carriage is complete and mounted upon its platform, the under surface having a slope of 4°, the upper will be horizontal while the ends will be vertical. Holes are cut in the brackets for the various fittings.

The bottom plate C is $\frac{7}{8}''$ thick, it has guides *h*, *h*, of angle iron riveted along its under surface, which fit between the sides of the platform, when the carriage is mounted, and keep it in a true position during recoil or running up. The rear ends of the guides are bent round at right angles to form carriage stops. If the carriage is fitted for the Elswick compressor, an opening for the plates is cut in the bottom plate and a bar of angle iron riveted across just in rear of the opening, to stiffen the plate and to serve as a bearing for the compressor plates. The bottom plate is planed where the brackets rest upon it.

The transom B is formed of plate iron $\frac{5}{8}''$ thick riveted along the lower edge and the sides to a frame *j*, of angle iron, the upper edge of the plate is curved to admit of sufficient depression being given, when required, to the gun.

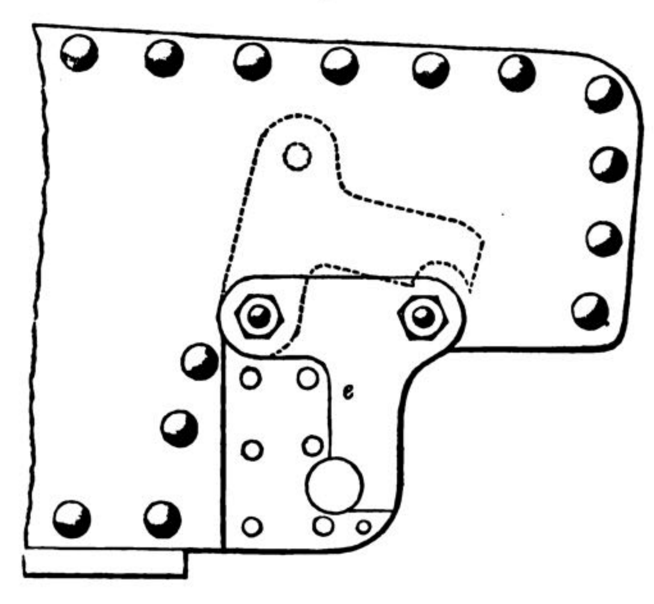
The knee stays D, D, are of scrap iron, one supports each bracket in rear and strengthens its attachment to the bottom plate. Each stay is riveted to the bottom plate and bolted to the bracket.

The brackets stand upon the bottom plate and are secured to it by screws, the heads of which are countersunk. The transom also stands upon the bottom plate, an angular packing piece being between them, and is bolted both to it and to the brackets, supporting the latter in front. The bearing surfaces of the bottom plate and angle guides are planed so that the carriage may slide smoothly upon its platform.

The carriage is fitted with four metal rollers, which have lubricating holes in them, and run upon iron axles. The axle of each front roller, 2″ in diameter rests in metal bearings, each attached to the bracket by two screws, which latter act as feathers in slots in the head of the axle and prevent it turning round in its bearing: the axle is put in from the

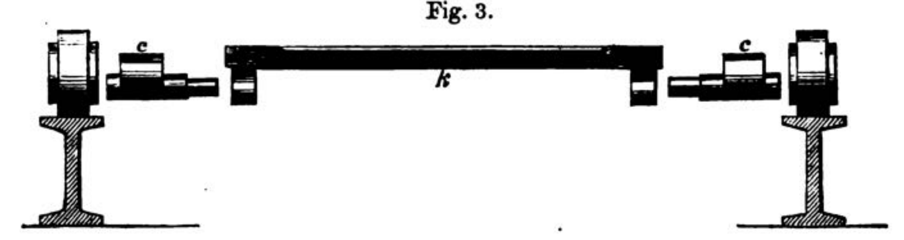
outer side and keyed upon the inner with a galvanized iron key. The axles of the rear rollers *d, d,* are eccentric, 3·258″ in diameter, and are secured in the brackets by what are termed "drop plates" *e, e,* in such a

Fig. 2.



manner that they can be readily removed, namely, by taking out the rear bolts of the drop plates, and turning the latter upwards (see Fig. 2) upon their front bolts as pivots, when the axles are freed.* The axles *c, c,* are united by a bar, termed the "connecting bar," *k,* so that when worked

Fig. 3.



they may move simultaneously. In the bar there are two holes for the reception of iron-pointed levers, by which the bar can be turned and the rollers thrown into or out of gear as desired. The inner end of each axle is made hexagonal in order that a socket to receive the iron-pointed lever may be fitted upon it in place of the connecting bar, should the latter be damaged. To prevent the rear rollers coming into play in the recoil of the carriage a stop is riveted on the inside of each bracket. When the carriage rests in its normal position upon the platform the front rollers have a clearance of ·05″ and the rear of ·1″.

Fittings. Elevating gear is fitted on each bracket, and the gun moved by working both sides simultaneously. On each side (see Fig. 1) it consists of,—

A wrought-iron elevating arc (not shown in Fig.)

A pinion *n,* 7·91″ in greatest diameter, fixed to a spindle, both of wrought iron.

---

* In the first made carriages the axles were not connected by a bar, and the rollers were worked by sockets fitted on their axles outside the brackets.

A metal friction roller *m*, attached to an iron spindle, with metal nut and steel pin.

A capstan head *o*, of wrought iron.

A jamming lever *p*, of wrought iron.

The elevating arc is pivoted to the gun and passes on the inside of the bracket between the friction roller and the pinion; it has teeth upon its rear edge, which gear in the teeth of the pinion, and a groove upon the front for the roller to run upon, so that the latter not only keeps the arc in gear with pinion, but prevents it moving from the side of the carriage. The spindles of the friction roller and pinion pass through metal bearings in the bracket, the former is secured by a metal nut and steel pin, the latter has upon it the capstan head and jamming lever. The capstan head has a boss upon the inner side, which keeps it clear of the rivets of the carriage, and holes in its periphery for the iron-pointed lever by which it is turned; when thus moved it turns the spindle, as it has feathers on it, which enter slots in the latter, and the spindle by its pinion moves the arc. The jamming lever screws upon the spindle outside the capstan head, so that when tightened upon the latter it clamps the pinion. The thread of the spindle in the right bracket is left-handed, and of that in the left bracket right-handed, so that both the jamming levers clamp by turning to the rear.

The capstan heads are interchangeable for either side of the carriage, the pinions with their spindles are not, nor are the elevating arcs. The arcs and pinions are marked with the nature of gun to which they belong, and the word "top" is stamped upon the upper end of each of the former.

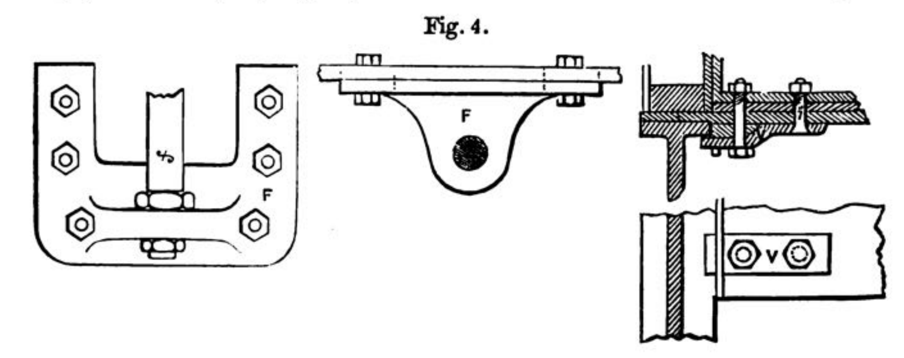
A metal trunnion plate, *g*, Fig. 1, is secured in each trunnion hole by countersunk screws, and a capsquare secured over it by two feathered keys which are chained to the brackets. The capsquares are interchangeable from one side to the other, and also from one carriage to another of the same nature, though for convenience they are marked with the number of the carriage to which they are particularly fitted.

A metal bearing, *x*, Fig. 1, is fitted in the hole in each bracket for the breeching rope used in the sea service.

A front and rear eye bolt for tackle is bolted to each bracket, a stud for a preventor rope to the bottom plate and a buffer block of elm to the front transom, also a loop for the priming wires is attached to the right bracket.

If the carriage is fitted for the hydraulic buffer, the fitments are simply a bracket, F, Fig. 4, bolted to the under side of the bottom plate

Fig. 4.



in front, through an oval hole in which the end of the piston rod *f*, passes for attachment, and two clip plates V, which are also bolted underneath the bottom plate. The clip plates project one on each side through a slot in the front of the guide plate, and hold the carriage

during recoil to the platform, thus preventing the piston rod being bent. The buffer itself will, more properly, be described with the platform.

If the carriage is fitted for the Elswick compressor, the fitments are as follows :—

Two joints or brackets *o*, *o*, Fig. 5, in which the rocking levers are pivoted, bolted beneath the bottom plate, one at either side of the opening in it.

Two brackets *d*, *d*, one for the support of each shaft, bolted on the bottom plate by the same bolts that secure the rocking lever joints.

Metal bearings, one in each bracket for the shafts.

An arc on each bracket for the levers of the shafts to work on.

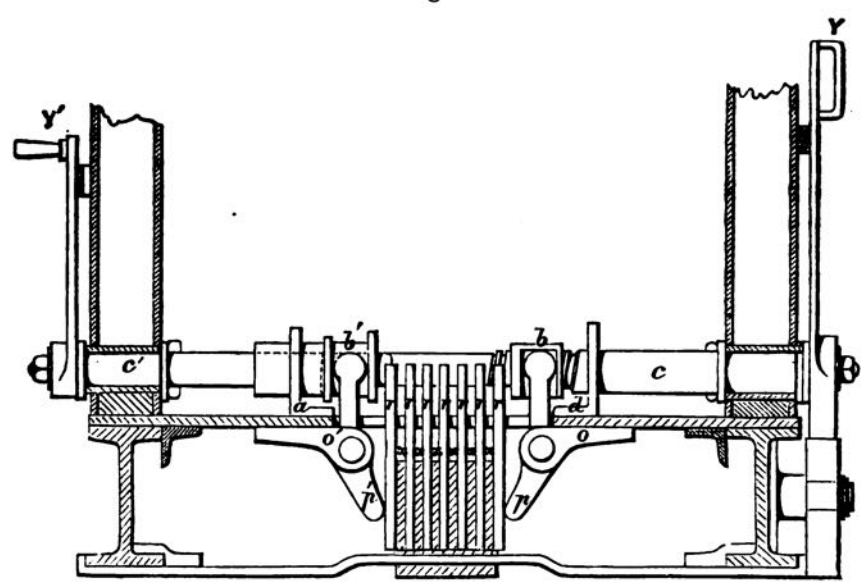
A bracket with elastic pad and plate over it, bolted to the right bracket of the carriage, to act as stop to the lever on that side.

Compressor. E.O.C. for double-plate carriages.

The compressor, which is known as the "Elswick compressor for double-plate carriages," is in principle the same as the Elswick compressor for single-plate carriages, but an improvement upon the latter in having the same shaft to work both rocking levers, whereby the strain of compression is transferred from the brackets of the carriage to the shaft itself.

The parts of the compressor are as follows :—

Fig. 5.



Compressing shaft *c*, with collar, nut, metal collar, and solid key.

Adjusting shaft c^1, with collar, nut, metal collar, and solid key.

Compressing rocking lever *p*, with pin and split key.

Adjusting rocking lever p^1, with pin and split key.

Compressing lever Y, of steel.

Adjusting lever Y^1, of steel, with key and chain.

Compressing nut *b*, of metal.

Adjusting nut b^1, of metal.

Compressor plates *r*, *r*, *r*, seven in number, the two outer ones thicker than the remainder.

Supporting bar with two screws, and two stops with screws, for the compressor plates.

The compressing shaft passes from the right bracket of the carriage through the nut of the right-hand rocking lever and into the nut of the left-hand lever; it has cut upon it a left and a right-handed screw thread, the former to work the right-hand lever, and the latter to work the left-hand. As therefore the compressing lever is thrown down and the shaft turned, the nuts move from each other, and compression is put on by the lower ends of the rocking levers moving towards each other. When the compressing lever is thrown up, the nuts travel towards each other, and compression is taken off.

To admit of adjusting the left rocking lever to any position, according to the amount of compression required, and yet at the same time not to interfere with the motion of the adjusting nut on turning the compressing shaft, there are long slots in the adjusting shaft which feathers in the nut enter. By this means, though turning the adjusting lever will place the nut in a new position on the compressing shaft, yet the nut is free to move in or out as the latter shaft is turned. Moving the adjusting lever up its arc increases the compression, moving it down diminishes it. The proper amount of compression is attained when one man can just force the compressing lever beneath its catch.

The adjusting and compressing lever and the compressor plates are identical with those of the Elswick compressor for single-plate carriages; the latter are supported in the same manner as in the single-plate carriages, namely, resting with their lower slots on the transom, and their higher slots on the supporting bar.

The jaws of the compressing rocking lever are rather wider apart than those of the adjusting rocking lever, while the compressing nut is shorter and of different form to the adjusting nut.

Painting the carriage.

Before the several parts of the bracket of a carriage are put together the interior surfaces receive one coat of Pulford's black. When the carriage is complete the upper surface of the bottom plate and about 2″ up the brackets are painted with a coat of red lead, and after with one of Pulford's black, the remainder of the carriage, bearing surfaces and metal work excepted, receiving two coats of Pulford's black.

Marking.

A metal plate, with the nature, mark, register number, and date of manufacture engraved on it, is attached to the outside of the left bracket, or if the carriage has been made by Sir William Armstrong & Co., the name of the firm and register number is engraved on the top of the right bracket in rear.

9″ M.L.R. of 12 Tons Carriage. Mark I.

9″ M.L.R. of 12 tons carriage, Mark I.

Construction.

As already stated, this carriage is similar in construction to the 7″; the plates of the brackets are $\frac{1}{2}$″ and the width of the frame 4″, making a total thickness of bracket of 5″. The thickness of the bottom plate is $\frac{7}{8}$″, and the diameter of the axles of the front rollers, 2″. Before the adoption of running-back gear for the 9″ carriage, the eccentric axles (4″ in diameter) of the rear rollers were formed and connected as in the 7″ carriage, while further a projecting socket or bracket was fitted to the rear end of each cheek of the carriage to take the bearing and admit of the use of roller handspikes on emergency. Since the adoption of running-back gear, the eccentric axles and connecting bar are formed in one piece, termed the "eccentric shaft." This shaft is $2\frac{1}{8}$″ in diameter, its ends are made hexagonal for the reception of sockets to take the iron-pointed levers, while in the shaft itself there are holes for the same levers in case of the sockets being damaged. The shaft is supported at the centre by a metal bracket,* which is bolted to and

* This, though of metal, is painted with remainder of carriage.

projects from the bottom plate, to serve as the point of attachment of a double block for running-back tackle. This bracket is in two parts, connected by a bolt (with round head), so that the shaft can readily be withdrawn when required.

Upon the outside of each cheek of the carriage an iron stop is bolted, against which in the recoil the sockets of the eccentric shaft can bear, and so prevent the rear rollers coming into play. In running-up, the same stops take the bearing of movable pawls attached to the sockets, so that on bringing the rollers into play and placing the pawls the iron-pointed levers may be withdrawn.

Fittings.

The sockets for the iron-pointed levers are of iron, each with an hexagonal hole through the centre to fit on the shaft, and having a pawl hinged to it by a pin and secured by a split key. The socket itself is also secured on the shaft by a split key.

The shell of the block for the running-back tackle is of iron, and has a tee-shaped shank to enter a corresponding recess in the end of the bracket bearing of the eccentric shaft. When pushed home into the recess and given a quarter turn, the block is fixed. The sheaves of the block are metal, and take 3″ rope, they are held by a bolt secured by a pin, one end of the bolt forming a stud for the attachment of the end of the fall.

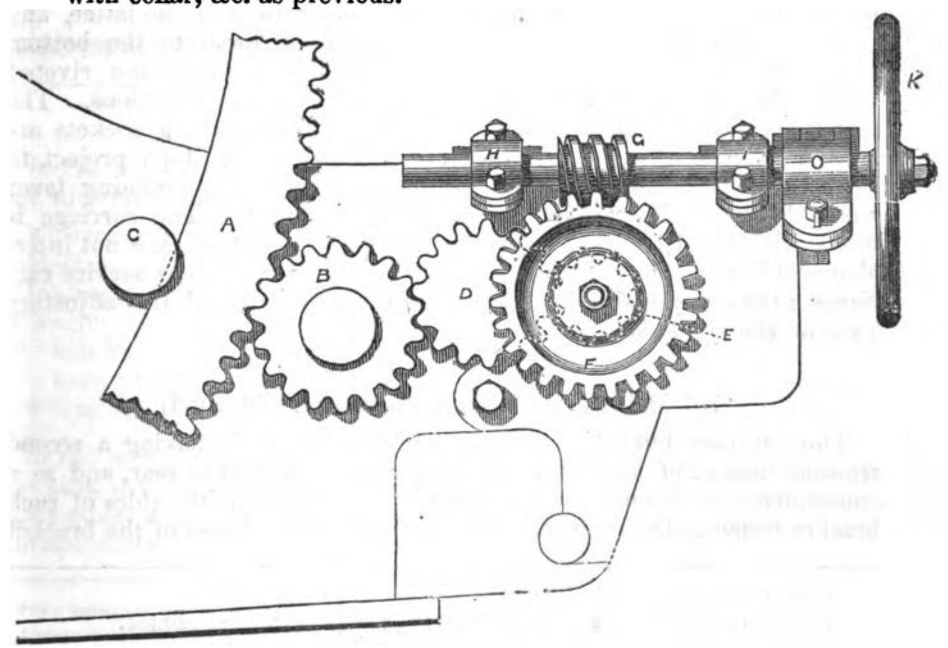
On all the 9″ carriages yet issued the elevating arrangement is the same as described for the 7″, the parts of the gear, except the elevating arcs and the pinions, being interchangeable with those of the latter carriage. New pattern gear has been approved for future manufacture, similar to the gear already in use with the 10″ carriage. It is fitted on both sides of the carriage, but only to be worked on one at a time, and an arrangement is made by which the side not in use can be thrown out of gear. On each side, the parts of the gear are as follows :—

Elevating arc A, of wrought iron.

Metal friction roller C, on iron spindle, with metal nut and steel pin.

Pinion for arc B, 7·91″ in diameter on spindle, both of wrought iron, with iron collar, metal nut, and steel pin.

Intermediate pinion D, 6·9″ in diameter on spindle, both of iron, with collar, &c. as previous.



Metal worm wheel F, 9″ in greatest diameter, and pinion of iron E, 4·3″ in diameter on iron spindle, with two iron collars, metal nut, steel keep pin, and iron hexagonal nut.

Worm shaft G, of iron * 23½″ long and 2″ in diameter, with metal hand wheel C, iron collar, and nut.

The spindles rest, as usual, in metal bearings in the side of the carriage, the arc passes, as in the capstan head elevating gear, between the friction roller and the arc pinion on the inside of the bracket, the intermediate pinion gears in this pinion, and the pinion on the spindle of the worm wheel with the intermediate pinion, so that by turning the worm wheel the arc is moved. The wheel is worked by the worm shaft, which is held by caps H, I, secured by screws, in two† metal brackets bolted to the side of the carriage. On the rear metal bracket a clutch O, is hinged, secured by a steel pin and retained by a swivel key: to throw the endless screw out of gear with the worm wheel the clutch is thrown back and the shaft turned and drawn to the rear until the collar on it, which at first was to the front of the clutch, comes to the rear of it, when the latter is replaced and holds the shaft as desired.

The friction roller and its spindle are interchangeable with the same parts of the capstan head gear. The arcs and arc pinions are marked with nature of the gun, and the upper ends of the former " top." The worm wheels and the shafts are right and left, and are accordingly marked " R " or " L." It will hereafter be seen that the pinion on the spindle of the worm wheel is smaller than the corresponding pinion of the gear of the 10″ carriage, which is to give greater gain of power on account of the greater preponderance of the older 9″ guns.

If the carriage is fitted for the hydraulic buffer the fittings are as in the 7″; the clips are longer, but the bracket is interchangeable with that of the 7″ carriage. If fitted for the Elswick compressor the fittings also correspond to those of the 7″ carriage, and are interchangeable with them, except the shafts.

9″ M.L.R. of 12 Tons Carriage. Elswick Pattern.

9″ M.L.R. of 12 tons carriage, Elswick pattern. (See L. of C., § 1584 for illustration.)

This carriage is the same in general construction as the R. C. D. pattern: the brackets slope away in rear more than in the latter, and there are two transoms instead of one, both screwed to the bottom plate. The metal bearings for the trunnions of the gun are not riveted to the brackets, but form cylinders fitting over the trunnions. The rear rollers have cranked axles united by a bar on which sockets are fitted to receive iron-pointed levers. Two buffers or stops project to the rear from the bottom plate of the carriage. The jamming lever works between the capstan head and the bracket. The carriage is fitted with the Elswick compressor, the parts of which are not interchangeable with the parts of the same compressor on the service carriages: the compressing lever is placed upon the left and the adjusting lever on the right side.

10″ M.L.R. of 18 Tons Carriage. Mark I.

10″ M.L.R. of 18 tons carriage, Mark I. (See R.C.D.)

This carriage differs in construction from the 9″ in having a second transom instead of knee stays to support the brackets in rear, and as a consequence a second stay or packing piece between the sides of each bracket frame at the position of that transom. The frame of the bracket

* To be shortened ¾″.

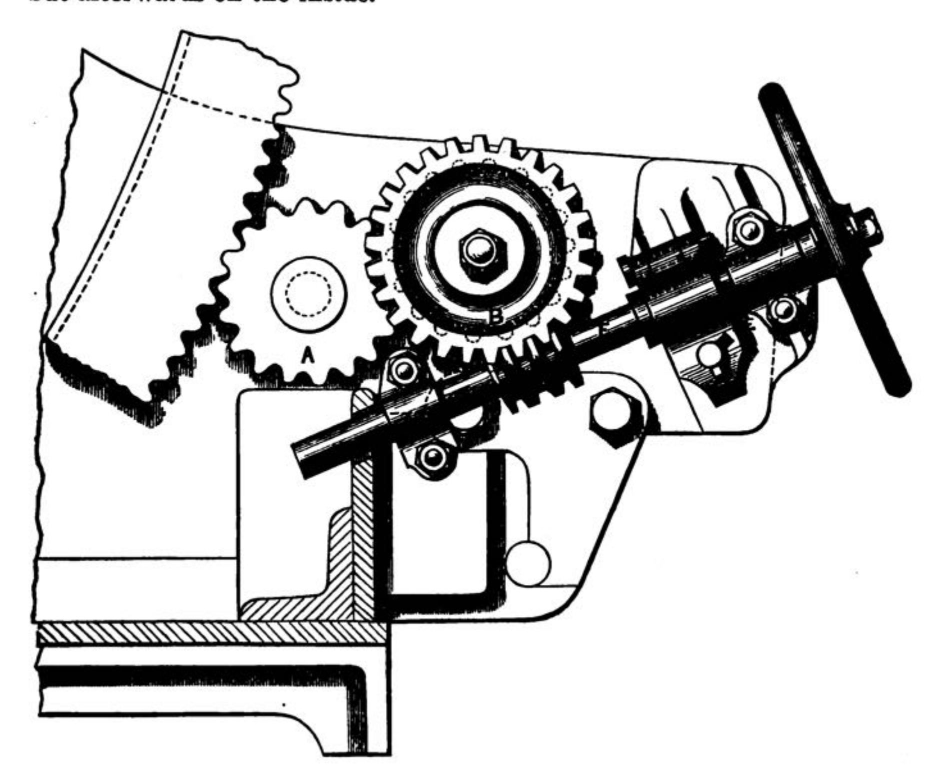
† In painting the carriage, these brackets, though metal, are painted.

is 4″ wide, the plates each $\frac{5}{8}$″ thick, making a total thickness of $5\frac{1}{4}$″ and the bottom plate $\frac{7}{8}$″. There is no angular packing piece under the front transom, and no angle stay across the bottom plate.

photolithographs, 133 and 133A.)

The rear rollers are worked by an eccentric shaft * (as in the 9′ carriage), $2\frac{1}{2}$″ in diameter; the axles are 4″. The sockets for the iron-pointed levers and the block for the fall of the running-back gear are interchangeable with those of the 9″, but not the metal supporting bracket: the latter has its parts connected by a bolt with a square instead of a boss head. The axles of the front rollers are 2″ in diameter.

The elevating gear is the "worm wheel and worm;" on a few of the first manufactured carriages it was placed on the outside of the brackets, but afterwards on the inside.



In the latter case the parts on each side are as in the 9″ carriage, but without an intermediate pinion with spindle; viz.—

Elevating arc.
Friction roller on spindle, with nut and pin.
Pinion A, 7·91″ in diameter, on spindle, with collar, nut, and pin.
Worm wheel B, 9″ in diameter, and pinion 7·91″ in diameter, on spindle, with two collars, one metal nut, one hexagonal nut, and a keep pin.
Worm shaft F, with hand wheel, collar, and nut.

In the second pattern gear, namely, that fitted on the inside of the brackets, the friction roller, worm wheel, and hand wheel are interchangeable with the same parts of the 9″ gear, and the arcs, arc pinions, shafts, and worm wheels are marked as in the latter. In the

* In some of the first made carriages the axles of the rollers were not connected, and were worked by sockets outside the brackets.

first pattern gear there is no second pinion and the parts, except the friction rollers, are not interchangeable with those of the second pattern; the worm shaft is 1·5″ in diameter instead of 2″, and the clutch is placed on the front instead of on the rear bracket. In the second pattern the worm shaft is $25\frac{5}{16}$″ long.

As already stated, the 10″ carriage has not been fitted for the Elswick compressor: the fitments for the buffer are as in the 9″ carriage, the bracket being the same, but the holding-down clips longer.

10″ M.L.R. of 18 Tons Carriage. Mark II.

10″ M.L.R. of 18 tons carriage, Mark II. (Low.) (Plate XV.)

This carriage is constructed on Captain Scott's principle, namely, with low brackets and the bottom of the carriage forming a well, which fits between the sides of the platform, when the carriage is mounted. The well admits of a high elevation being given to the gun, which the adoption of low brackets would otherwise prevent.

The carriage consists of two long low brackets connected by two transoms. The brackets are formed in the same manner as other double-plate carriages, but their frames are of cast instead of wrought iron. The width of the frame is 4″, and the thickness of each plate 0·$\frac{3}{4}$″, giving a total thickness of $5\frac{1}{2}$″ to the bracket.

The transoms are each box-shaped, i.e., with back, front, and ends of plate iron united along the edges by being riveted to angle iron.

The brackets are riveted to the ends of the boxes or troughs in such a manner that the latter project considerably below the former, and not only admit of elevation being given to the gun, but also guide the carriage as it slides upon its platform; the bottom plate is riveted beneath the transoms, completing the well.

The rear rollers are completely hidden in their recesses in the brackets, and the front nearly so, the latter being sufficiently uncovered to admit of handspikes being applied in front to scotch them when necessary.

The front rollers are 1″ more in diameter than those of Mark I. carriage, and their axles are $2\frac{1}{2}$″ instead of 2″. The rear rollers are the same as in Mark I. carriage, and worked in the same manner by an eccentric shaft secured by drop plates, but not supported by a centre bearing. The block of the running-back tackle is attached to the hind transom, when used.

The elevating gear is the same as in Mark I. carriage, but the shafts and arcs are not interchangeable with those of the latter carriage, the arcs having the pivot holes in a different position, and the shafts being of different length and 2″ in diameter. The latter are supported each in two metal brackets. The pitch diameter of both pinions of the gear is the same, viz., 5·187″.

The carriage is fitted for the hydraulic buffer, the bracket for the piston rod being bolted under the front transom. The clips are of different form to those of Mark I. carriage, and are bolted to the front of the front transom.

11″ or 12″ M.L.R. of 25 Tons Carriage. Mark I.

11″ or 12″ M.L.R. of 25 tons carriage, Mark I. (R.C.D. photo-lithographs, 137 and 137A.)

This carriage is similar to the 10″, Mark I., but has an angle stay across the bottom plate. The brackets are the same thickness as in the latter carriage, and the rollers together with the axles of the front rollers are also the same. The bottom plate is 1″ thick.

In the first 12″ carriage manufactured the eccentric axles of the rear rollers were made as in the 7″ carriage, and connected in the same manner by a bar. Such carriages were fitted with the capstan head

CARRIAGE FOR 7 PR. R.M.L. STEEL GUN OF 2000 LBS

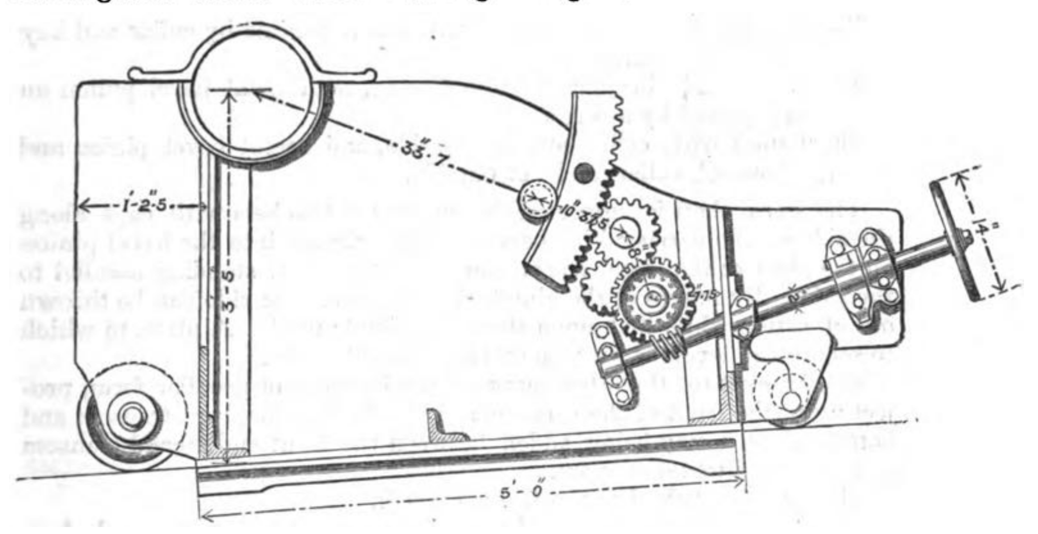
SCALE $\frac{1}{15}$TH FULL SIZE

2' 1".75

9' 3".0

elevating gear, the parts of which, except the arcs and their pinions, were interchangeable with the parts of the gear in the lower natures. Again, these carriages had the Elswick compressor, but with nine instead of seven plates, except the shafts all the parts being interchangeable with the same compressor in the 7″ or 9″.

In the later carriages the rear rollers have an eccentric shaft 2½″ in diameter, and a bracket fitted with a treble block for the fall of the running-back tackle. Their elevating arrangement is the worm wheel



and worm similar to the 9″, that is, with an intermediate pinion. The latter and the worm wheel pinion are each 5·9″ in diameter, and the worm shaft is 2″ in diameter and 43⅝″ long. These parts, and also the arcs and arc pinions, are not interchangeable with those of the 9″, nor, except the arc pinions, with those of the 10″.

The fitments for the hydraulic buffer are identical with those of the 10″ carriage.

* 12″ M.L.R. of 35 Tons Carriage. Mark I.

12″ M.L.R. of 35 tons carriage, Mark I.

This carriage is constructed on Captain Scott's principle, namely, with low brackets, the frames of which are of cast iron and a well between them.

The brackets are supported and connected by three transoms, and each is further strengthened by a knee-stay. The two front transoms are formed in the usual way by plate riveted to a frame of angle iron. The rear transom has angle iron at each side only. The front transoms and knee-stays are riveted in the usual manner to the brackets and bottom plate, but to form the well between the brackets their under sides project beyond the brackets 4″, and the spaces between them and the brackets filled in by angle iron riveted to the latter and to the bottom plate. The second transom is placed just in rear of the trunnion holes, and the knees more to the rear, while the rear transom unites the ends of the brackets without touching the bottom plate.

The brackets are 5½″ in width, their plates ¾″ thick, and the bottom plate 1″.

The axles of the front rollers are 3″ in diameter.

The rear rollers are worked by an eccentric shaft (eccentrics 7″ in diameter) and hydraulic jack, the upper end of which is attached by a

* Experimental.

bolt to a metal bracket bolted upon the left cheek of the carriage, while the lower end has a crank on it which is keyed on the eccentric shaft. The latter is made in two parts secured together by a coupling with pins.

The elevating gear is special; it is on the worm-wheel principle, and consists of the following parts on each side :—

Elevating arc.

Two friction rollers.

One pinion keyed on a spindle.

Worm wheel with metal clutch with lever, secured by collar and key on spindle of pinion.

Worm shaft $2\frac{1}{4}''$ in diameter and 2′ long, with metal bevel pinion on front secured by a screw.

Short shaft with collar and pin inside, and metal bevel pinion and hand wheel, collar, and nut outside.

The worm shaft is supported in two metal brackets with caps along the side of the carriage, its bevel pinion gearing into the bevel pinion on the shaft of the hand wheel, the latter therefore standing parallel to the side. By means of the clutch the gear upon one side can be thrown out of action while that upon the other side is used. A plate, to which to secure the lever, is fixed upon the top of the side.

The bracket for the attachment of the buffer is of peculiar form, projecting to the front of the carriage; it is bolted to the front transom and bottom plate, a stay being added between the front and second transom to give it additional support.

The clips are bolted to the front transom.

For the running-back gear three single snatch blocks are attached to the rear of the well to take a fall of $3\frac{1}{2}''$ rope.

* 10″ M.L.R. Howitzer of 6 Tons Carriage.

10″ M.L.R. howitzer of 6 tons carriage.

The carriage designed for the 10″ rifled howitzer is a double-plated sliding carriage with a shallow well.

The brackets in the upper part differ considerably in form from those of an ordinary gun carriage; their frames are of wrought iron $4\frac{1}{2}''$ wide, and the plates are $\frac{3}{4}''$ thick. The inner plates extend beyond the lower edges of the frame to form the sides of the well, and to them the bottom plate is attached by means of angle iron. A front and rear transom form the ends of the well, the latter very high, and its upper edge straight from bracket to bracket.

The trunnions of the howitzer lie in metal bearings in movable trunnion blocks, in which they are secured by capsquares, of special form, with bolts. Each trunnion block rests upon an elastic pad formed of alternate plates of india-rubber and wrought iron in a recess in the bracket, in which both block and pad are free to move. This arrangement is made to reduce the strain upon the platform when the howitzer is fired at a high angle of elevation.

The eccentric shaft of the rear rollers is formed in two parts, which are coupled together at the centre of the carriage, and the rollers are brought into play in the usual manner by iron-pointed levers in sockets with pawls, one at each extremity of the shaft outside the bracket.

The elevating arrangement on each side consists of a toothed rack working in a vertical guide formed on the inside of the bracket, and attached to the howitzer by a movable link. The rack is worked by a worm-wheel arrangement, with intermediate pinion, as in the 9″ M.L.R.

* Designed only.

and other carriages. 10° of depression or 70° of elevation can be given to the howitzer.

The carriage is fitted in the usual manner for the hydraulic buffer.

Muzzle Pivoting Carriages.

Muzzle pivoting carriages.

For casemates in certain forts of peculiar construction muzzle pivoting carriages, 9″, 10″, and 12″, are about to be made. The name "muzzle pivoting" is used, because in such carriages the gun will be capable, as it were, of pivoting, in a vertical plane, round a point at its muzzle, and will thus admit of considerable elevation or depression being obtained through a port of small height, which otherwise the size of the port would render impossible.

The muzzle pivoting arrangement will be somewhat as follows;—the trunnions of the gun will rest, each, in a metal block sliding in a slot formed in the bracket of the carriage, and in the centre of the carriage a hydraulic lift will be placed; the ram of the latter, when in action, will take a bearing under the trunnion coil of the gun and it will be set in action, as desired, by lever handles outside the brackets. The hydraulic lift will be supplemented by a screw jack, under each trunnion block, worked by toothed gear set in motion by a winch handle outside each bracket in rear. The screw jacks are intended to take the blow due to the discharge of the gun and not the hydraulic lift.

Remarks upon the gear of the double-plate carriages.

The following remarks with respect to the gear of the double-plate carriages may be useful:—

* Front rollers; the same for the 9″, 10″, Mark I., and 11″; special in other carriages.
Front roller axles; the same for 10″, Mark I., and 11″; special in other carriages.
Rear rollers; special for 7″ and for 12″ of 35 tons; same in all others.
Rear roller axles fitted for bar }
Connecting bars }
Eccentric shafts } special to each carriage.
Brackets for block }
Blocks; the same for 9″ and 10″; special for 11″.
Sockets with pawls, universal.
Elevating arcs, special to each carriage.
Arc pinions, special, except 10″ and 12″, which have the same.
Capstan heads, universal.
Jamming levers, ,,
Friction rollers, ,, , except 12″ of 35 tons.
Friction roller spindles, special, except 10″ and 11″, which have the same.
Intermediate pinions, 9″ and 11″, not the same.
Worm wheels, universal.
Hand wheels, ,,
Worm wheel spindles, special, except 10″ and 11″, which have the same.
Worm wheel pinions, special in each.
Worm shafts, ,,
Brackets for worm shafts ,,
Elswick compressor, parts universal, except the shafts, which are special in each.
Hydraulic buffer, bracket, universal, except in 12″ of 35 tons.
Clips, special, except in 10″ (Mark I.) and 11″, which have the same.

* The gear of the 9″ Elswick pattern is not included, nor the 10″ elevating gear fitted outside the bracket.

CHAPTER-VIII.—WROUGHT-IRON PLATFORMS FOR DOUBLE-PLATE CARRIAGES.

Table.

Nature.	Weight with Gear.	Tonnage.	Width between sides.	Nominal Length.	Slope.	Diameter of Truck. Fore.	Diameter of Truck. Hind.	Height from ground to axis of Trunnions.	
	cwts.	tons.	in.	ft.	°	in.	in.	ft.	in.
7″ M.L.R. casemate, fitted for E.O.C. compressor.	55½	3·700	34½	15	4	8½	13	4	1
Ditto, fitted with buffer -	52¼	3·864							
7″ M.L.R. dwarf "A.", fitted with buffer.	77	7·158	34½	15	4	18	24	5	8½
7″ M.L.R. dwarf "C.", fitted with buffer.	80¼	6·733	34½	15	4	24	24	5	8½
7″ M.L.R. dwarf "D.", fitted with buffer.	80¾	7·350	34½	15	4	24	18	5	8½
9″ M.L.R. casemate, fitted for E.O.C. compressor.	*65½	4·075	42	15	4	8½	13	4	1½
Ditto, fitted with buffer -	69½	5·695							
9″ M.L.R. dwarf "A.", fitted for E.O.C. compressor.	*90½	8·425	42	15	4	18	24	5	9
Ditto, with buffer - -	97	9·045							
9″ M.L.R. dwarf "C.", fitted with buffer.	101½	7·612	42	15	4	24	24	5	9
9″ M.L.R. dwarf "D.", fitted with buffer.	103¼	7·900	42	15	4	24	18	5	9
9″ M.L.R. casemate, Elswick pattern.	63¼	3·975	42	15	4	19½	13½	4	9½
10″ M.L.R. casemate, Mark I.. (low) with buffer.	95½	6·654	47	15	4	10	13	4	2½
10″ M.L.R. casemate, Mark II. (high), with buffer.	106	6·037	49½	15	4	18	18	4	2½
10″ M.L.R. dwarf "A.", with buffer.	134¼	7·845	47	15	4	18	24	6	0
10″ M.L.R. dwarf "C.", with buffer.	136¾	8·035	47	15	4	24	24	6	0
10″ M.L.R. dwarf "D.", with buffer.	141	8·507	47	15	4	24	18	6	0
11″ or 12″ M.L.R. casemate, fitted for E.O.C. compressor.	*98½	5·850	56	15	4	10	13	4	11½
Ditto, with buffer - -	110	6·085							
11″ or 12″ M.L.R. dwarf "A.", with buffer.	*119	8·125	56	15	4	18	24	6	3
11″ or 12″ M.L.R. dwarf "C.", with buffer.	136¾	9·091	56	15	4	24	24	6	3
†11″ or 12″ M.L.R. dwarf "D.", with buffer.	‡142	‡8·375	56	15	4	24	18	6	3
12″ M.L.R. of 35 tons casemate, with buffer.	137¾	10·172	59¼	13¾	4	13	18	4	11½
10″ M.L.R. howitzer.	‡116	—	41·0312	14½	2½	18	18	5	6

* Without traversing gear. † None yet issued. ‡ Estimated.

Remarks.

In the traversing platforms for double-plate carriages each nature of carriage has its own platform. The 7″ platform is the only one which will take a single-plate carriage, and either the 7″ or 9″ single-plate carriages can be mounted upon it, as they are the same distance from outside to outside of the guide plates as the 7″ double-plate carriage.

In each nature the platforms are made "casemate" and "dwarf," differing from each other in the height, the former being low for use

in casemates, and the latter high (therefore mis-named)* for open batteries. They are convertible from one to the other, but only by skilled artificers.

Casemate platforms are always "A" pivot, the pivot being imaginary. Dwarf are made for "A," "C," and "D" pivots, the first-mentioned being imaginary, as before, the last two actual.

Except in one instance, namely, the 9″ casemate, Elswick pattern, when the front and rear trucks of a platform are of different diameter, those of the greater diameter are those furthest from the pivot and which have therefore in traversing to cover most ground.

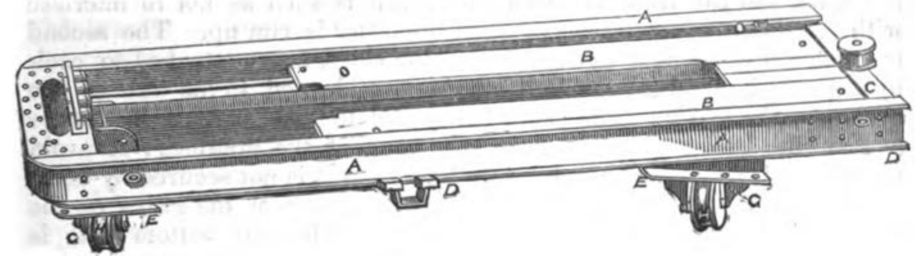
The 9″ and higher natures of platforms are now fitted with traversing gear, which consists of a system of cog wheels and shafting by which the two larger trucks of the platform are made to revolve. The gear is worked in some cases by one winch handle at the rear of the platform, in others by two, one at each side, towards the rear; the manner of working any particular platform depends upon the battery in which it is mounted.

The first issued 7″, 9″, and 12″ platform were fitted for the Elswick compressor, corresponding to the same carriages, the later issues with the hydraulic buffer. The former, when returned to R.C.D. for repair, unless they are for re-issue for particular carriages fitted with the Elswick compressor, are altered and fitted with the buffer.

7″ M.L.R. of 7 Tons Casemate Platform. Mark I.

7″ M.L.R. of 7 tons casemate platform, Mark I. (See R.C.D. photo-lithograph, 61.)

The platform consists of two sides, A, A, two transoms, C, C, two bottom plates, D, D, two truck plates, E, E, a top plate F, a diagonal stay, four flanged feet, G, G, and four trucks, H, H.



Construction.

The sides are of girder iron 10″ deep and $5\frac{1}{2}$″ wide in the tee, each is bent round in front and is planed upon the upper and under surfaces as well as along the sides of the tees.

The front transom is of 1″ plate riveted along the top and sides to a frame of angle iron; if the platform is fitted for the buffer there is a hole in the plate for the end of the piston rod to enter when the carriage is run up. The rear transom is of girder iron 7″ deep and 4″ wide in the tee.

The top plate is 1″ in thickness, and has a hole slotted in its length to give access to nuts beneath it.

The bottom and the truck plates are plain plates, the former $\frac{7}{8}$″ and the latter 1″ thick.

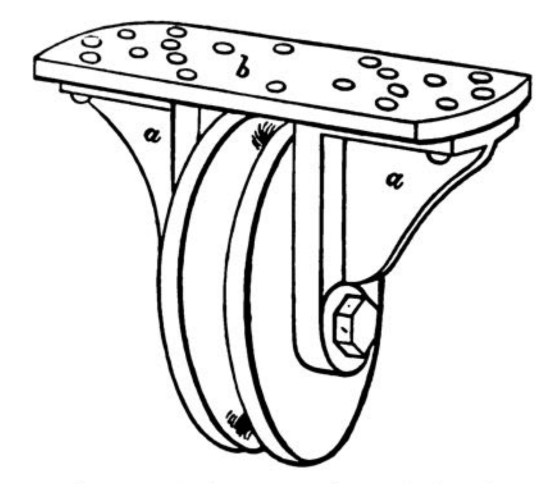
The diagonal stay is of 1″ plate, and formed of a centre piece to which four arms are welded in the shape of the letter X.

The flanged feet for the front of the platform consist, each of a fore and hind flange or knee forged from scrap, with holes in them to receive

* The dwarf platform received its name of "dwarf" because when introduced the then service platform, now obsolete, was much higher.



the axles of the truck. The feet for the rear of the platform consist also, each of a fore and hind flange *a*, *a*, but which are riveted to a connecting plate *b*.



The trucks are of wrought iron, metal-bouched; they are cylindrical, hollow soled, the rear trucks having, however, but one flange on the front side.

The sides of the platform are parallel to each other, their bent extremities meet in front and are held together by a connecting plate which overlaps their junction on the inside and is bolted to their webs. The front transom is slightly let into the sides one foot from the breast and secured to them by bolts. The top plate is bolted over the front of the sides and the front transom; its width is such as not to interfere with the rollers of the carriage when the latter is run up. The second transom unites the rear extremities of the sides, being attached to each by a knee plate bolted to itself on the outside and to the web of the girder on the inside. The front bottom plate lies between the lower tees of the girder sides, 6′ from the front of the platform; to avoid weakening the sides at that point by bolt holes it is not secured by bolts, but to each by a clip which overlaps the lower tee of the girder on the outer side, and is bolted to the plate itself. The rear bottom plate is bolted underneath the rear of the platform to the transom and sides. The truck plates are bolted beneath the girder sides, one in front, the other 10′ more to the rear; between the latter and each side is placed an angular packing piece of iron in order to give the platform the necessary slope. The diagonal stay lies between the truck plates, its extremities bolted to the sides and its centre to the front bottom plate. The flanged feet are bolted underneath the truck plates in such a position that when the trucks are in them the latter shall be set to suit the pivot and at the proper distances from it. The axles of the trucks are of steel, $2\frac{3}{8}''$ in diameter; each is secured in its flanged foot by two nuts on the inner side.

Fittings. A foot plank B, for standing upon, of sabicu or teak 10″ wide, with a supporting block attached beneath each extremity, lies from one bottom plate to the other, along the inside of each side of the platform. The space left in the centre between the planks is for the bars of the Elswick compressor, or for the hydraulic buffer: if the platform is for the former the planks are bevelled off on the inner edge, and two short 6″ planks fill the space between the ends of the bars and the rear transom.

A bollard for the preventor rope is fitted upon the rear transom: the bollard is of sabicu and fits upon an iron spindle, on which it is held by

a nut; the spindle is bolted to the transom. If the platform is fitted with the buffer, the bollard is 9″ high, if for the compressor 6″ high.

To form a stop for the carriage when run up, a piece of angle iron is bolted on the top plate, and a piece of elm or sabicu again to the rear of this: upon these are fitted four small indian-rubber buffers, consisting each of an indian-rubber ring 2″ thick upon a spindle 6½″ long, with a large and nearly flat head. The spindle with the ring on it passes through the sabicu block and angle iron, and is secured in front by a flat key.

To form stops for the carriage in recoil, an iron bracket with projecting stop is bolted on the inside of each side of the platform, 3′ 2½″ from the end if the platform is fitted for the buffer, and 1′ 2″ if fitted for the compressor. Each stop has an indian-rubber ring the same as in the front stop, but with a spindle 2″ shorter.

Eye bolts for tackle are bolted one in front and one in rear on each side; a fifth eye is also placed vertically under the centre of the rear bottom plate, it is formed in one piece with the eye for the transporting dilly.

Staples are bolted to each side in front and rear to receive brackets on which the side arms rest. The brackets are 8″ in length in front and 9½″ in rear.*

Axletree bands to receive the transporting axle are riveted to the clips of the front bottom plate, a slot being made in each clip to admit of the linch-pin being placed. An eye to receive the pintail of the transporting dilly is bolted to the centre of the rear bottom plate.†

If the platform is fitted for the Elswick compressor the fitments are as follows:—

A bracket to support the bars in front is bolted to the back of the front transom.

A bracket to support the bars in rear is bolted to a bent plate, which is fitted between the sides and bolted to their lower tees, just over the rear truck plate.

A small bracket with spindle and stop for the tripper, is bolted to the right side near the front.

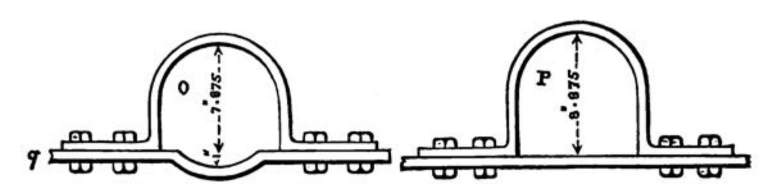
Six compressor bars ⅝″ thick, 10′ 10″ long, and 6½″ deep are hung in their supporting brackets by pins which are secured by keys, on each pin between the plates an iron ring or collar being placed.

The tripper is of iron steeled, and is secured on its spindle by a collar and key.

If the platform is fitted for the hydraulic buffer, the following are the fittings:—

A bearing plate *q*, (Fig. 1) bolted across the platform on the diagonal stay for the support of the front of the buffer.

Fig. 1.



* *i.e.* The same length as the front and rear brackets for 10″ platforms and upwards.

† The following additional fittings are now added to all iron platforms, namely:—A movable foot plank or stage over the sides, extending from the stops to the rear, for No. 1 to stand upon; brackets on each side for carrying an iron-pointed lever; a water tank for wetting the sponge head upon the rear of the right side.

Two holding-down bands *o*, *p*, which, when the buffer is placed, lie over it and are bolted, one to the bearing plate, the other to the rear bottom plate. The front band *o*, is 1″ lower than the rear *p*. The rear bottom plate and the lower tee of the rear transom are slightly hollowed out to form a bed for the end of the buffer, and the upper tee of the transom is slotted.

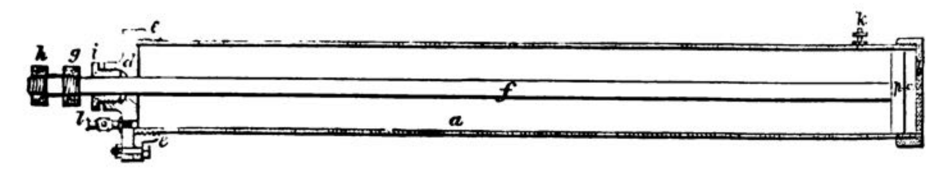
A plate staple is secured by screws upon the inside of the right side towards the rear, for holding the spanner for moving the gland.

The hydraulic buffer. (See R.C.D. photo-lithograph, XIII.)

The weight of the hydraulic buffer is $4\frac{3}{4}$ cwt., its tonnage ·222 tons, and its greatest length and diameter respectively 87·5″ and 14″. It consists of the following parts, namely:—

Cylinder *a*, Fig. 2, of wrought iron.
Cover *d*, of cast iron, with eight bolts.
Flange *e* „
Cap *b* „

Fig. 2.



Piston *p*, of wrought iron.
Piston rod *f*, of wrought iron, with collar nut *g*, and connecting nut *h*.
Plug *k*, for filling hole, of wrought iron.
Packing gland *i*, of metal.
Emptying cock *l*, of metal.

The cylinder internally is 77·375″ long, and 8·07″ in diameter, and will hold 12 gallons 5 pints; the cap screws upon and closes one end, while the flange screws upon the other. The cover, through which there is a hole for the piston rod to pass, and on the outer side round that hole a recess for packing, is bolted to the flange, so closing the cylinder at that end. Both the flange and the cover are flat on their upper edges to admit of the carriage in recoil passing over them, and the thread on the flange is so cut, that when screwed home, the flat edge will come to the proper position. To make close joints, Scott's mineral composition is smeared over the screw threads of the cylinder and flange, before the latter is put on, and the same mixed with chopped hemp is laid between the flange and cover before they are bolted together. The packing placed in the cover recess, to ensure a close joint round the piston rod, consists of a piece of tow about $1\frac{1}{4}$″ in circumference, and 3′ 7″ long, which is greased with tallow, wound round the rod and pushed into the recess. It is kept in its place and squeezed as tight as required against the rod by the packing gland, which passes over the rod, and screws into the recess, and in this manner is made so tight that a man can just move the rod in or out. A special spanner is made for turning the gland, but McMahon's spanner or the knock-up wrench will serve the purpose. A zinc pan to catch any drip from the gland in firing is suspended from the front of the buffer. A hole is drilled and tapped in the upper surface of the cylinder near the rear end for filling it through, and is closed by the screw plug, which is secured by a chain to the right foot-board of the platform. For emptying the cylinder a hole is drilled and tapped in the under part of the cover in front, in the same vertical plane

as the filling hole when the buffer is in position, and is closed by the metal cock. A small spanner is issued for the buffer, one end of which turns the cock, and the other the filling-hole plug. The piston is 8·04″ in diameter, and has four circular holes, each 1·25″ in diameter, drilled through it. The piston rod screws into the piston, and is kept from turning by a keep screw. The collar nut screws on to the rod a few inches from the end, and the buffer being in position, and the end of the rod passed through the bracket on the carriage, the connecting nut upon the very end; the bracket is thus held between the two nuts, and the piston therefore obliged to move with the carriage. To prevent the piston rod being bent when the rear of the carriage is raised upon its rollers, the bracket is allowed $\frac{1}{16}$″ play between the nuts in manufacture, and it is usual in practice to increase the amount of the play by giving the connecting nut half a turn back after having screwed it home. For the same reason, namely, to avoid bending the rod, the hole in the bracket, as already mentioned, is made oval.

In connecting the buffer to the platform the cap is made to bear fairly against the rear transom, the flat edges of the flange and cover are brought parallel to a straight edge laid over it across the sides of the platform, and at right angles to them, and before bolting down the bands, leather packing pieces are placed between them and the cylinder in order that they may be made tightly to grip the latter.*

For use the buffer is filled with 12 gallons of Rangoon oil, which may be measured in a gallon measure issued for the purpose, or tested by measuring the depth at the filling hole, which the platform standing at the correct slope of 4°, and the carriage being run out to the front stops, should be $4\frac{5}{8}$″.

The buffer checks the recoil by the resistance which the oil in it offers to the piston, the rod of the latter being connected to the carriage; at the same time the holes in the piston permit of certain motion of the latter by giving the oil vent to escape from behind it. The amount of resistance offered to the piston's motion is proportional to the quantity of oil in the cylinder, and inversely proportional to the size of the holes in the piston. In the 7″ gun, with battering charge, the cylinder having 12 gallons of oil in it, and the holes in the piston being 1·25″ in diameter, the carriage, under ordinary circumstances, has a recoil of about $5\frac{1}{2}$ ft. that is, it is brought up just short of the stops. With the service charge it is usually unnecessary to reduce the quantity of oil, but if the recoil is not sufficient to allow of the gun being easily loaded, it is easy to run out a little oil, letting air in at the same time by loosening the plug.

As already seen, the cylinder will contain 12 gallons 5 pints, but 12 gallons is the maximum quantity of oil put into it, leaving thus a small space filled with air: the latter being compressible acts as a cushion and reduces the violence of the blow on discharge of the gun.

The cylinder of the buffer is marked with a register number and the flange with the same number, because it is not interchangeable from one buffer to another, on account of the screw threads being accurately fitted to bring the flat edge of the flange uppermost. The nature of the gun is marked upon the piston rod between the nuts. Excepting the rod, nuts, and metal parts, the buffer receives two coats of Pulford's black when complete, and upon the upper surface of the cylinder is lettered in

---

* It is proposed also, in order to keep the cylinder from turning round, to have a small screw through the front band into it.

white the number of gallons it is to be filled with, and the then depth at the filling hole.

Altering a platform fitted for E.O.C. compressor to take the buffer.

To alter a platform fitted for the Elswick compressor to take the buffer, the bracket supports for the bars are removed, the hole cut in the front transom for the end of the rod, the tees of the rear transom cut, the stops moved further forward, and a higher bollard fitted upon the transom, after which the usual fittings for the buffer and the plate staple for the small spanner are added.

Marking.

A brass plate is attached to the rear transom with the nature of platform, mark, weight, date of manufacture, and register number engraved upon it. If the platform has been made by the Elswick Ordnance Company, the name of the firm and register number are cut upon the upper surface of the right side.

Painting.

All the under surfaces of the platform receive one coat of red lead and then one of Pulford's black, the remainder receives two coats of Pulford's black, bearing surfaces excepted, such as the surfaces of the sides on which the carriage slides, the soles of the trucks and bearing portion of their axles, &c. The register number is painted in white on the rear transom.

7″ M.L.R. of 7 Tons Dwarf Platform, A. Pivot. Mark I.

7″ M.L.R. of 7 tons dwarf platform, A. pivot, Mark I. (See R.C.D. photolithograph, 61B.)

Construction.

This platform differs in construction from the preceding, by being made of greater height. This is arranged by using 18″ trucks in front and placing a block of sabicu $5\frac{1}{4}$″ thick, with an inch plate on it, and angular packing pieces above the plate, between the sides and the front truck plate, while at the same time the fore and hind flanges of the front feet are connected by a plate in the same manner as the hind. In rear 24″ trucks are used and an iron knee stay placed between each side and the truck plate.

Fittings.

The fittings of the platform are the same as before, with the addition of a side step bolted from one truck plate to the other on each side of the platform.

7″ M.L.R. of 7 Tons Dwarf Platform, C. Pivot. Mark I.

7″ M.L.R. of 7 tons dwarf platform, C. pivot, Mark I. (Plate XVI.)

This platform is raised to the same height as the dwarf A, by placing an angular packing piece between each side and the front truck plate, and a knee stay between each side and the rear truck plate; 24″ trucks are used both front and rear, the fore and hind flange of each foot being bolted to a connecting plate.

As from the position of the "C" pivot it is possible to use an actual pivot, a longitudinal pivot plate and a cross stay are added to the platform for the purpose. The cross stay is a bent plate with pivot hole in the centre, which is bolted beneath the front bottom plate. The pivot plate extends from one truck plate to the other in the centre of the platform, and is bolted to those plates with packing pieces between, and to the cross stay; it has a pivot hole in it corresponding to the hole in the latter.

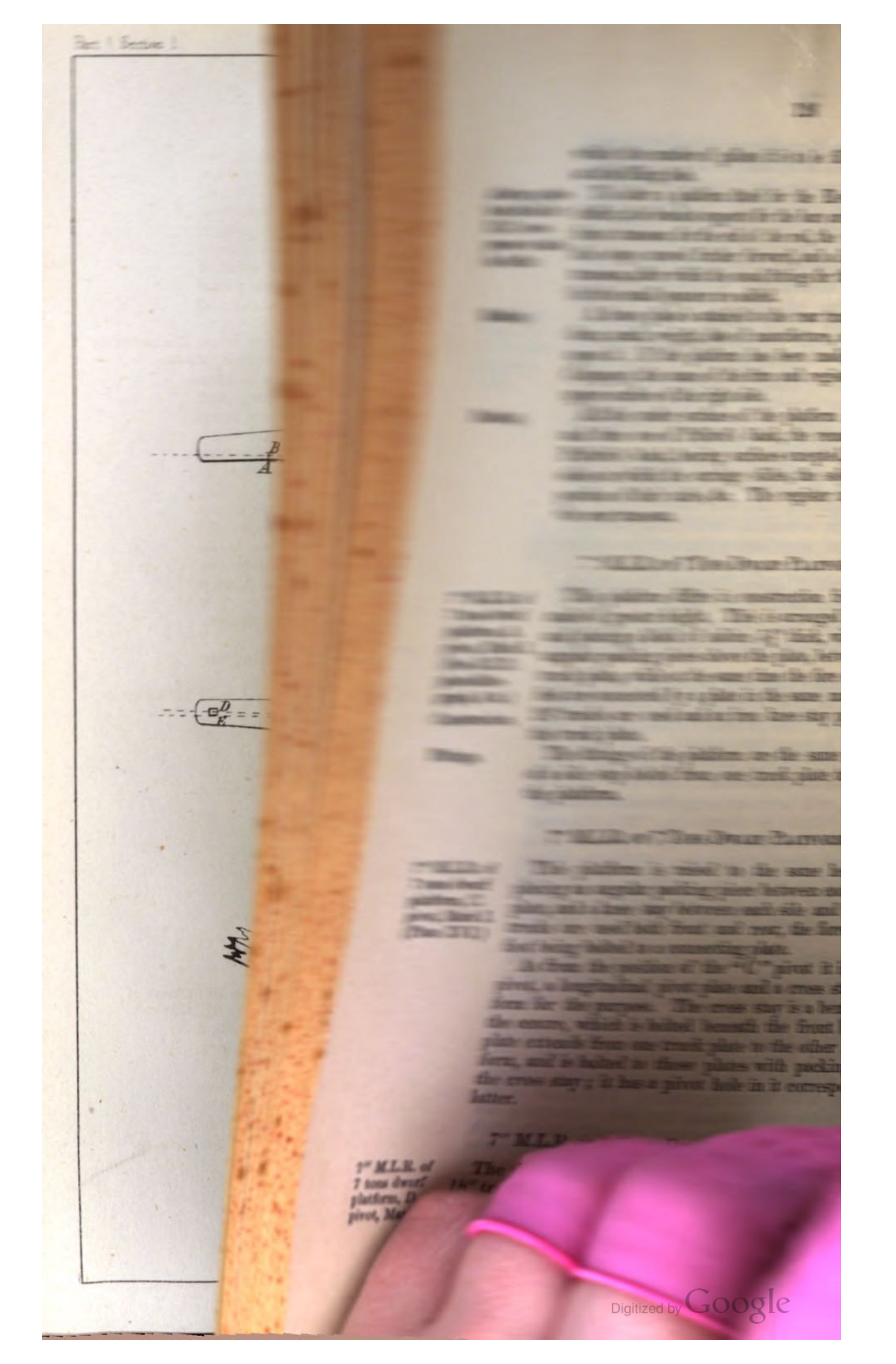
7″ M.L.R. of 7 Tons Dwarf Platform, D. Pivot. Mark I.

7″ M.L.R. of 7 tons dwarf platform, D. pivot, Mark I.

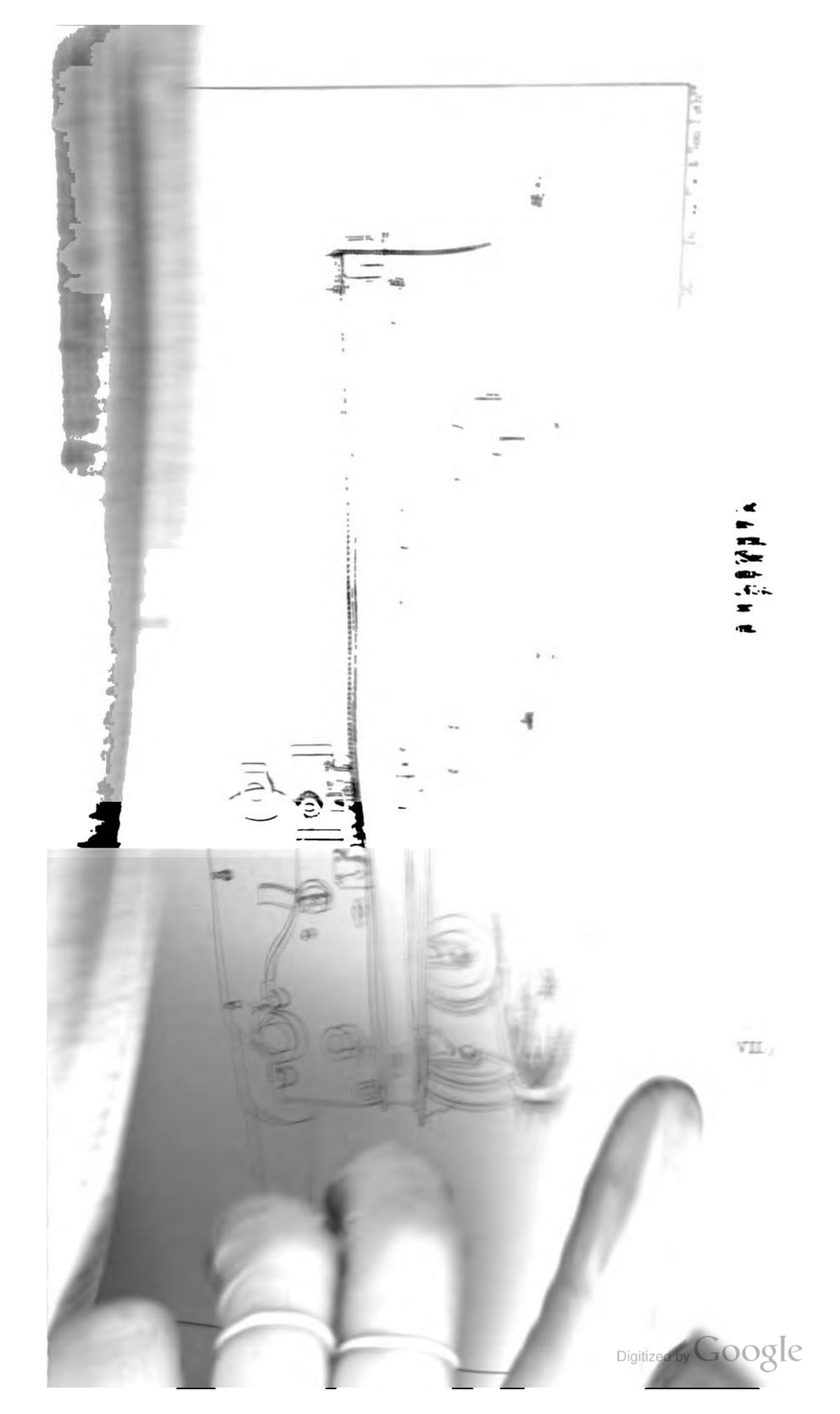
The dwarf D. differs (see Fig.) from the dwarf C. platform in having 18″ trucks in rear instead of 24″, and in addition to a knee stay between each side and the rear truck plate, a sabicu block, and plate. The pivot hole is in the pivot plate just in front of the rear truck plate.

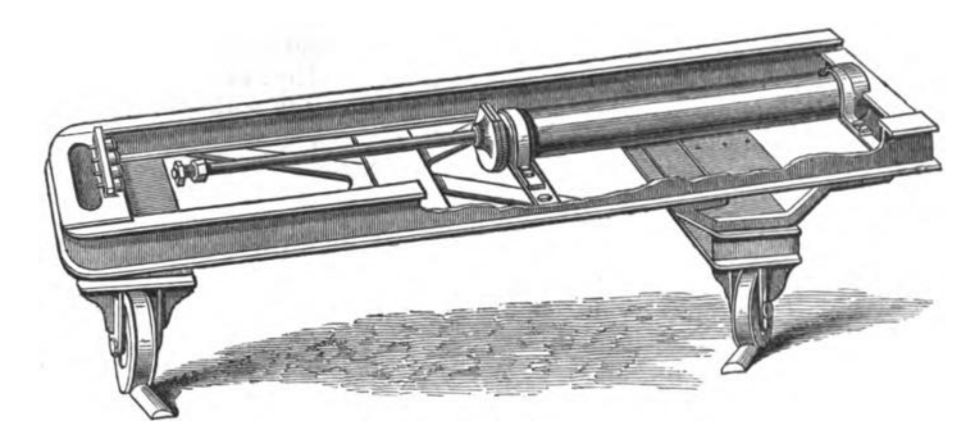
7 INCH 7 TON W^{T} IRON CARRIAGE AND DWARF PLATFORM.

(C PIVOT.)



B
A
D
E





***9″ M.L.R. of 12 Tons Casemate Platform. Mark I.**

This platform is of precisely similar construction to the 7″ casemate, differing from the latter only in the width between the sides and in the strength of the girder iron. In the first made 9″ platforms the sides were found to be too weak and were strengthened by plates of iron riveted along each side of the web; in the more recently manufactured platforms the web of the girder has been increased in thickness from 1″ to 1⅓″, which has been found to yield strength enough.

9″ M.L.R. of 12 tons casemate platform, Mark I. (See R.C.D. photo-lithograph, 61G, without gear.)

Construction.

The trucks, with their axles, are the same as in the 7″ platform, but the flanges are set at a slightly different angle to those of the latter platform on account of the difference in width between the sides.†

Fittings.

If the platform is fitted for the Elswick compressor, the tripper, which is longer than that on the 7″ platform, is the only fitment not interchangeable with those of the latter platform. The foot planks are 9″ wide.

If fitted with the hydraulic buffer, the latter itself is not interchangeable with the 7″ buffer, on account of the holes (four) in the piston being ·9″ ‡ in diameter instead of 1·25″. The foot planks are then 12″ wide.

As already mentioned, platforms for the 9″ gun are fitted with "traversing and running-back" gear,§ in some cases set in motion by two winch handles, one at each side, on a cross shaft in rear of and parallel to the rear transom of the platform, and in some cases by a single winch handle on a spindle projecting from the rear of the same transom. In both instances the same arrangement serves either to traverse the platform or to run the carriage back, means being provided to disconnect the part acting immediately on the trucks, as desired.

The following are the parts of the gear, with handles at the side, for a casemate platform, namely:—

(Plate XVII.)

Two bevel pinions, A, A, Plate XVII. of metal, with 17 teeth each, and attached one to each hind truck by two screws.

---

* 9″ platforms (and upwards) are now fitted with a pointer for use with a graduated arc.

† Platforms for casemates, where the pivot is 12″ from the inside of the port, have the trucks 3″ further to the rear than in the original pattern, and have also the indian-rubber buffers removed, which, the loop on the front transom of the carriage being removed also, admits of the muzzle of the gun protruding sufficiently when run up for firing.

‡ They have been 1″ in diameter up to the present, but one hole of such is to be plugged up.

§ The eye for the pintail of the transporting dilly is removed in 9″ platforms fitted with gear.

Two truck shafts B, B, of wrought iron, 2½″ in diameter.

Two bevel pinions C, C, of cast iron, each with 15 teeth, one for the outer end of each truck shaft, secured by key.

Two mitre pinions D, D, of cast iron, each with 18 teeth, one for the inner end of each truck shaft, secured by key.

One longitudinal shaft E, of wrought iron, 2½″ in diameter, with collar and screw to secure it. It has long feathers in front to receive the clutch pinion, and short in rear for the spur wheel.

One clutch mitre pinion F, of metal, 18 teeth, with slots to fit feathers on longitudinal shaft.

One iron lever for clutch, with pivoting bolt and key, and also keep pin with chain,

One spur wheel G, of cast iron, 62 teeth, with slot to fit feather on the longitudinal shaft.

One double pinion of metal, H, 10 teeth on spur part, 19 teeth on bevel part, with collar and pin to secure it.

One cross shaft I, of wrought iron, 2″ in diameter, with two collars with screws to secure, and two winch handles to work it.

One bevel pinion of cast iron, J, 19 teeth, for cross shaft, with key to secure it.

One cast-iron bollard K, for rear end of longitudinal shaft, with two keys to secure it.

One metal shell, with two sheaves, secured by pin and key.

One metal shell, with one sheaf, secured by pin and key.*

The truck shafts are held each in a cast-iron bracket with two metal bearings bolted under the rear truck plate. Each metal bearing is made in two parts, an upper and an under, the latter part being held in the bracket by a cap with two screws, so that by simply removing the cap the shaft is released from its bearing; the latter is provided with a lubricating hole. The longitudinal shaft is held in similar bearings and brackets, one bolted to the rear truck plate between the brackets of the truck shafts, and the other under the rear bottom plate. The collar with screw secure the shaft in front of the rear bracket, the clutch slides upon the front of the shaft, the spur wheel is placed immediately behind its rear bracket, and the bollard upon the rear end. The clutch lever is pivoted to a small bracket bolted to the left truck shaft bracket. This lever is fork-shaped at the end, each arm with a stud upon it, which lies in a groove round the clutch, so that when the lever is moved to the front or rear it will carry the clutch with it, but at the same time it will not interfere with the clutch revolving with its shaft. When the clutch pinion is thrown forward into gear with the mitre pinions of the truck shafts and the spur wheel on the longitudinal shaft made to revolve, the trucks must move, the bevel pinions on the other ends of the truck shafts being in gear with the truck pinions. If, however, the clutch pinion be thrown back out of gear with the mitre pinions of the truck shafts, though the spur wheel be moved the trucks will not be affected. The lever is retained in either position required by its keep-pin, which fits into a hole in a guide plate under the left of the platform.

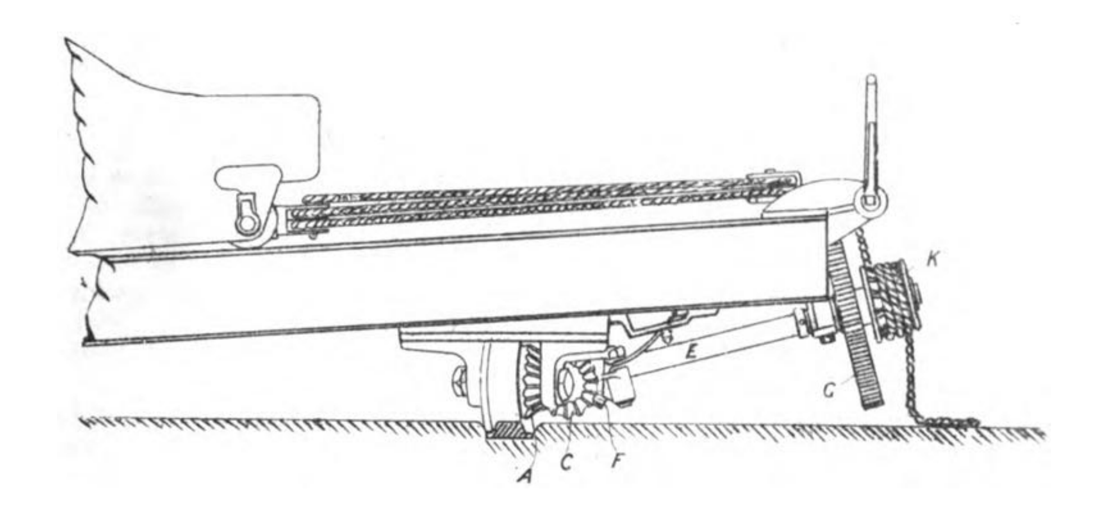
The double pinion fits upon a spindle bolted upon the rear transom, its spur portion gearing into the spur wheel of the longitudinal shaft, and its bevel portion into the bevel pinion of the cross shaft, which is supported in two similar brackets to those of the other shafts bolted to the rear transom. The clutch pinion being in gear, turning the winch handles from rear to front will traverse the platform to the right, and

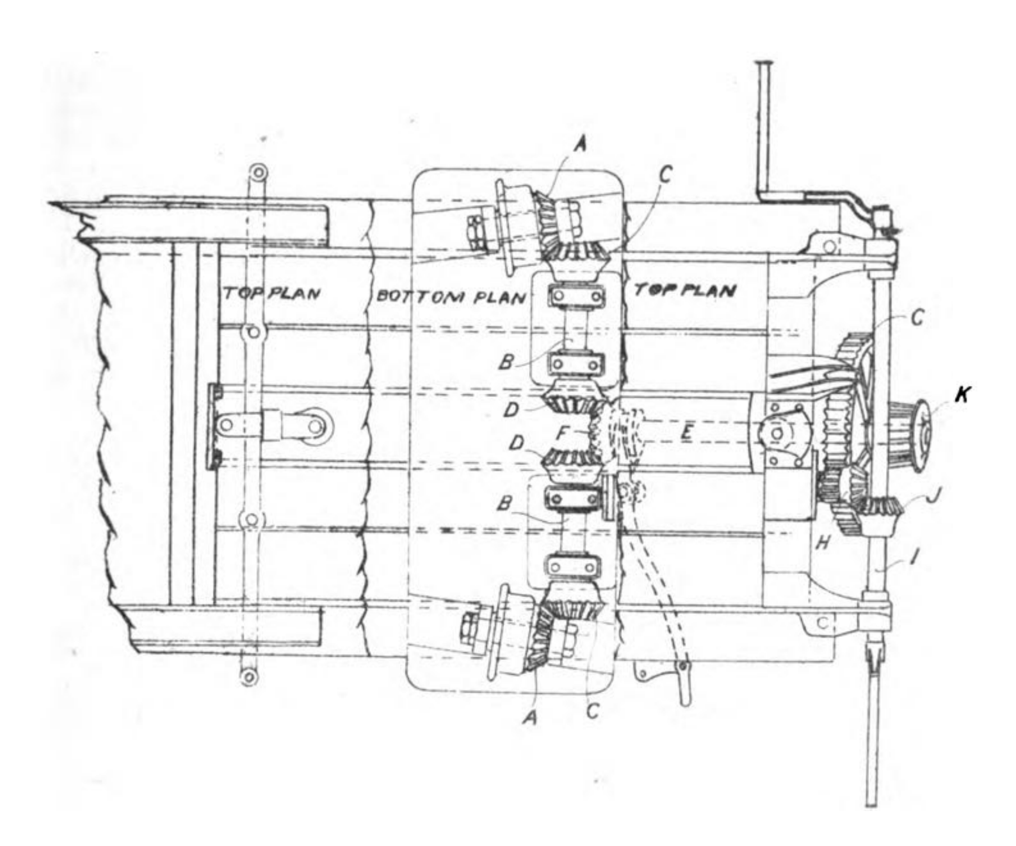
---

* In 9″ platforms and upwards, the exposed parts of the traversing gear is to be protected by a cover.

TRAVERSING GEAR.

FOR 9 IN CASEMATE PLATFORM.





Vincent Brooks Day & Son Ltd

turning them from front to rear to the left. The gain of power in traversing, neglecting friction, is 21·5 to 1.

Upon the top of the rear transom a bridge-piece of wrought iron is bolted, to the centre of which the shell of the double block* is bolted in a horizontal position, and to the right the shell of the single block in a vertical position, so as to lead the fall to the bollard. The clutch pinion being out of gear, and the fall passed round the bollard and held, when the winch handles are turned from rear to front the carriage, being on its rollers, will be run back. The gain of power is 22 to 1, exclusive of sheaves, and 110 to 1 inclusive, friction neglected.

If the gear is worked by one handle at the rear instead of two side handles, the parts are the same as before, except that there is no cross shaft, with pinion, &c., nor double pinion, and instead of the latter to drive the spur wheel there is a simple spur pinion of cast iron with ten teeth. This latter is keyed in the usual manner on its spindle, which is supported in two metal bearings, one bolted to the rear transom, the other to this bearing. The winch handle, which is bent to clear the bollard, fits upon the spindle. The gain in power in traversing is 21·5 to 1. Running back, exclusive of the sheaves, 22 to 1, *i.e.*, in both cases the same as with handles at side.

Except the bearing surfaces, the whole of the gear receives two coats of Pulford's black, and when fitted to a particular platform each part is lettered in white, with the register number of that platform.

9″ M.L.R. of 12 Tons Casemate Platform, Elswick Pattern.

9″ M.L.R. of 12 tons casemate platform, Elswick pattern. (See L. of C., § 1584, for illustration.)

Construction.

This platform is one which was specially constructed for the 9″ Elswick pattern carriages; its sides are of girder iron 12″ instead of 10″ deep, as in the service pattern; they are bent round to meet in front, as in the latter platform, but connected in a somewhat different manner throughout their length. The chief peculiarity of the platform is that it has but three trucks, one in front, and two in rear. The front truck is of larger diameter than the others, and is placed between the breast of the platform and the front transom at right angles to the longitudinal axis of the platform, and projecting through the bottom plate. The flange of each rear truck is bolted directly to the girder side.

All the platforms of this pattern have been fitted with the Elswick compressor, but neither the bars nor the tripper are interchangeable with the same fitments of the service pattern platform, and the latter is placed on the left side.

This pattern platform has not been fitted with traversing and running-back gear: as opportunity offers it will be brought up to the service pattern.

9″ M.L.R. of 12 Tons Dwarf Platform, "A" Pivot. Mark I.

9″ M.L.R. of 12 tons dwarf platform, Mark I. (Plate XVIII.)

The 9″ dwarf platform "A" pivot is of similar construction to the 7″ dwarf A pivot, taking the same flanges and trucks as the latter, but having the fittings for the compressor or buffer already mentioned in the description of the 9″ casemate platform as peculiar to the 9″.

No traversing gear with side handles has yet been made for this platform.

The traversing gear with one handle at the rear is on the same plan as the gear for the casemate platform, the pivot being the "A" in both cases, but the large wheel *a*, Plate XVIII. on the longitudinal shaft is a bevel instead of spur wheel, and both it and the pinion *b* which works it are

* In all platforms this will in future be made a simple movable block.

placed to the front instead of the rear of the bracket bearing of the shaft. This is done on account of the different arrangement of the running-back gear. In order to get greater gain of power in this the bollard has a bevel wheel *c* fixed to it, and is placed upon a spindle (that of the pinion working the large wheel) above the longitudinal shaft instead of on it, while a pinion *d* upon the extremity of the latter gears into its wheel, thus turning it as the shaft turns.

The parts of the gear are as follows :—

Two bevel wheels of cast iron *e*, 42 teeth, one secured to each hind truck by four screws.
Two truck shafts of wrought iron $2\frac{1}{2}''$ in diameter, each with collar and key to secure it.
Two bevel pinions *f*, of cast iron, 14 teeth, one for the outer end of each truck shaft, with key to secure it.
Two bevel wheels *g*, of cast iron, 38 teeth, one for the inner end of each truck shaft, secured by key.
One longitudinal shaft of wrought iron, $2\frac{1}{2}''$ in diameter, with collar and key.
One clutch pinion *h*, of metal, 18 teeth, with slots to fit feathers on front of longitudinal shaft.
One lever of wrought iron for clutch, with pivot pin and key, and also keep pin with chain.
One bevel wheel of cast iron *a*, 48 teeth, with slot to fit over feather on longitudinal shaft.
One spindle of wrought iron, $2\frac{1}{2}''$ in diameter, with collar and key to secure it, and winch handle to work it by.
One bevel pinion of cast iron *b*, 12 teeth, for inner end of spindle, with key to secure it.
One bevel pinion of cast iron *d*, 13 teeth, for rear end of longitudinal shaft, with key to secure it.
One cast-iron bollard, metal bouched.
One bevel wheel *c*, of cast iron, metal bouched, 32 teeth, attached to bollard.
One metal shell, with pin and key for two sheaves.
One ditto ditto one sheaf.
Gain of power in traversing, 35 : 1 ; in running back, 32 : 1.

The truck shafts are supported in three brackets beneath the rear truck plate, the centre bracket also receiving the front end of the longitudinal shaft. The bracket supporting the rear end of the latter is bolted to the rear bottom plate, and also supports the spindle of the pinion and bollard.

9″ M.L.R. of 12 Tons, Dwarf Platform, "C" Pivot. Mark I.

9″ M.L.R. of 12 tons dwarf platform, C. pivot, Mark I.

This platform is similar to the 7″ dwarf "C," except in the buffer, &c., as before.

It has only been fitted with traversing gear worked by handles at the side fitting on a cross shaft in rear of the rear transom, as in the casemate platform.

The pivot of the platform being in the centre, and consequently the front and rear trucks the same size, the trucks put in gear are a front and a rear truck upon the same side. *These are set in motion by means

* This arrangement of gear is approved only for emplacements not requiring more than 150° of training. In future manufacture it will be arranged with the handles at the centre instead of the rear of the platform, on the same plan as 11″ dwarf "C."

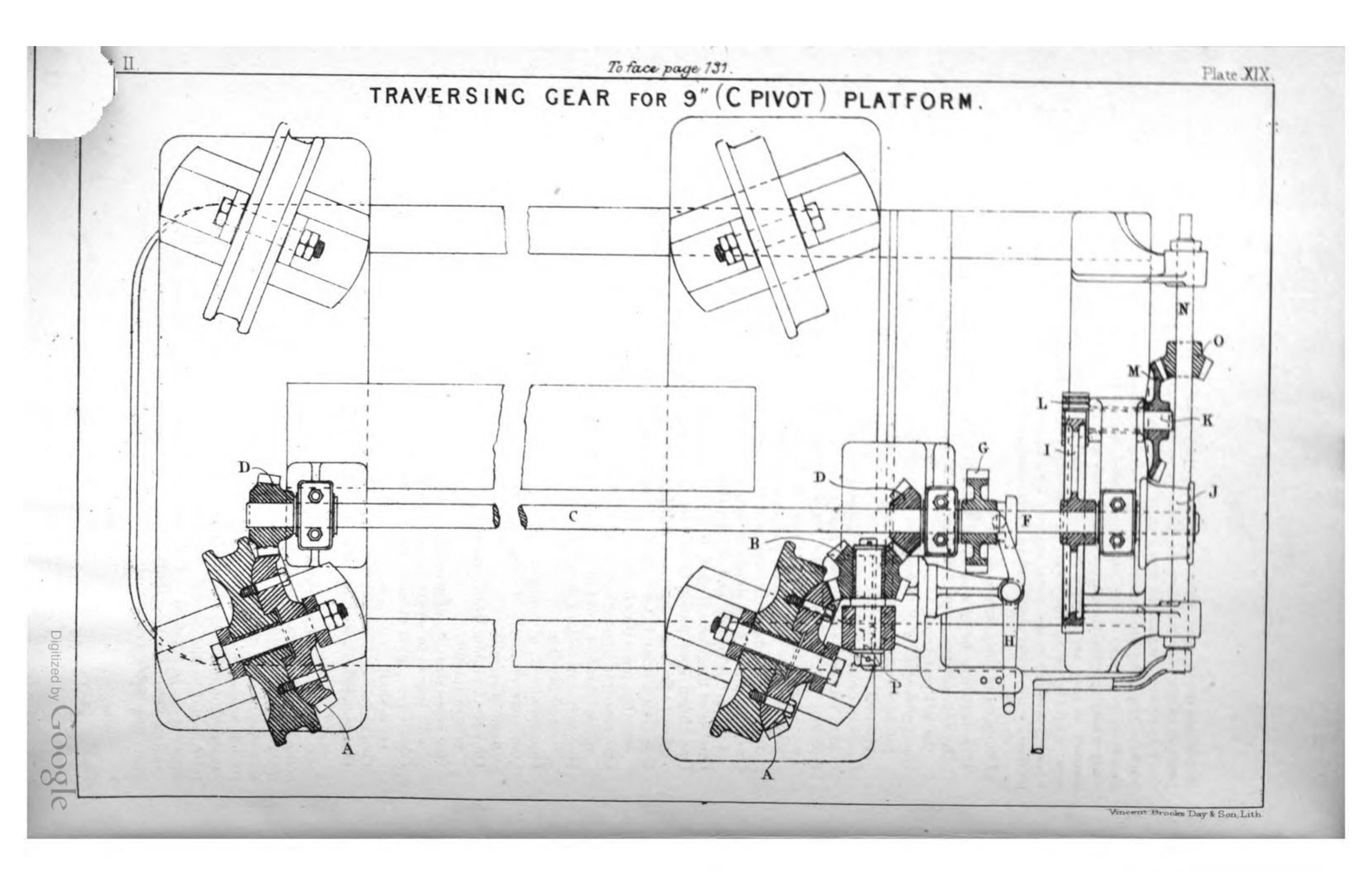
9 INCH 12 TON W^T IRON CARRIAGE AND DWARF PLATFORM.

(A PIVOT.)

Vincent Brooks Day & Son Lith

To face page 131.

TRAVERSING GEAR FOR 9" (C PIVOT) PLATFORM.



Vincent Brooks Day & Son, Lith.

of pinions on a long shaft, an intermediate pinion having, from the position of the rear truck, to be used between it and the pinion of the shaft in order to make the truck turn in the same direction as the front truck. The long shaft has a pinion upon its rear extremity for the clutch to gear into. The latter is placed above the pinion, upon the shaft which carries the large spur wheel and the bollard, in the same manner as they are carried in the casemate platform, except that the spur wheel goes to the front of the supporting bracket. The spur wheel is worked in the usual manner by a pinion, the latter being set in motion by the cross shaft and two intermediate bevel pinions. (Plate XIX.)

The parts of the gear are as follows :—

Two cast-iron bevel wheels A, A, Plate XIX., 40 teeth, one attached by four screws to the left front truck, the other in the same way to the left rear truck.
One truck spindle P of wrought iron, 2″ in diameter, with collar and pin to secure it on the inner end, and collar and hexagonal nut and pin on the outer end.
One cast-iron double pinion B, metal bouched, 18 teeth on each part, to fit on truck spindle and gear in truck wheel.
One long longitudinal shaft C, of wrought iron, $2\frac{3}{4}$″ in diameter.
Two bevel pinions of cast iron, D, D, 18 teeth, each, with key to secure it on long shaft, one in front of front bearing to gear in front truck, one in front of rear bearing to gear in double pinion.
One spur pinion (not shown in figure), of cast iron, 23 teeth, with key to secure it on rear end of long shaft.
One short longitudinal shaft F, $2\frac{1}{2}$″ in diameter.
One clutch spur pinion G, of cast iron, metal bouched, 23 teeth, with slots to fit long feathers on front of last-named shaft.
One clutch lever H, of wrought iron, with pivot bolt and pin, and also securing pin with chain.
One cast-iron spur wheel I, 62 teeth, with key to secure it on last-named shaft in front of rear bearing.
One cast-iron bollard J, with two keys to secure it on same shaft in rear of bearing.
One spindle K, of wrought iron, $2\frac{1}{4}$″ in diameter.
One spur pinion L, of cast iron, 13 teeth, with key to secure it on front of spindle.
One bevel pinion M, of cast iron, 35 teeth, with key to secure it on rear of spindle.
One cross shaft N, of wrought iron, 2″ in diameter, with two collars, with screws to secure it, and two winch handles to work it.
One bevel pinion of cast iron O, 15 teeth, with key to secure it on cross shaft.
One metal shell, with two sheaves, bolted to bridge piece.
One metal shell, with one sheaf, ditto

The long longitudinal shaft is supported under the left of the platform in three cast-iron brackets of the usual description; one bolted to the front truck plate, one to the pivot plate, and one to the rear truck plate, and to a stay, for the purpose, of plate strengthened by tee iron, which is riveted across the platform to the knee stays. The truck spindle is supported in a bracket bolted also to this stay and to the rear truck plate, while to the spindle bracket a smaller one for the pivot of the clutch lever is attached. The short longitudinal shaft is held in the rear bracket of the long shaft, and in a bracket bolted to the rear bottom plate, the latter bracket also receives the spindle of the spur wheel

pinion. The cross shaft is held as usual in two brackets projecting from the rear transom.

9″ M.L.R. of 12 Tons, Dwarf Platform, "D" Pivot. Mark I.

9″ M.L.R. of 12 tons dwarf platform, D. pivot, Mark I. (See R.C.D. photolithograph, 61H, without gear.)

This platform is similar to the 7″ dwarf "D," except in the buffer, &c. before mentioned.

It has only been fitted with traversing gear set in motion by handles at the side.

The pivot being to the rear of the platform, and the front trucks consequently the larger, they are chosen as those to be placed in gear, and are driven by means of a long shaft, which has a clutch upon its rear extremity. In prolongation of the long shaft and to the rear of it is the shaft carrying the spur wheel, this has a fixed clutch upon its front extremity, into which the sliding clutch can gear, so uniting the shafts. The spur wheel is driven in the usual way, but the cross shaft is placed under the sides of the platform instead of to the rear of the rear transom.

(Plate XX.)

The parts of the gear are as follows :—

Two cast-iron bevel wheels A, A, Plate XX., 34 teeth, one attached to each front truck by four screws.
One truck shaft D, of wrought iron, $2\frac{1}{2}$″ in diameter, with collar and screw to secure it on the right.
One bevel pinion of cast iron C, 32 teeth, for left extremity of truck shaft, with key to secure it.
One mitre pinion F, of cast iron, 38 teeth, with key to secure on truck shaft to left of right bearing.
One double pinion G, of cast iron metal bouched, 32 teeth, on part which gears in truck, 38 on the other portion.
One long shaft J, of wrought iron, $2\frac{3}{4}$″ in diameter.
One mitre pinion H of cast iron, 16 teeth, with key to secure it upon front of long shaft.
One metal clutch L, with slots to fit feathers on rear of long shaft.
One clutch lever X, of wrought iron, with pivot pin and key, and also keep pin with chain.
One short shaft N, of wrought iron, $2\frac{3}{4}$″ in diameter.
One clutch L^1, of cast iron, with key to secure it on front of short shaft.
One spur wheel W, of cast iron, 65 teeth, with key to secure on short shaft, between its bearings.
One cast-iron bollard U, with two keys for rear end of short shaft.
One wrought-iron spindle Q, with collar and hexagonal nut for each end.
One double pinion V, of cast iron, metal bouched, for spindle, 12 teeth on spur portion to drive spur wheel, 27 teeth on bevel portion.
One cross shaft R, of wrought iron, 2″ in diameter, with two collars with screws to secure it, and two winch handles to work it.
One cast-iron bevel pinion Y, 15 teeth, for cross shaft.
One metal double block, and one metal single block.
Gain of power in traversing 36·6 : 1, and in running back 34·6 : 1.

The truck shaft is held in two bearings of the usual description bolted under the front truck plate, the right-hand also receiving the point of the long shaft. The latter is also supported by a centre bearing of cast iron and a rear bearing of metal, the former bolted to the pivot plate, the latter to the rear truck plate. The front bearing of the

To face page 132.

9IN "D" DWARF TRAVERSING GEAR

short shaft is bolted upon the sabicu block plate, its rear bearing, which also takes the spindle, to the rear bottom plate. The brackets for the cross shaft are bolted, one under each side and the rear bottom plate, projecting inwards.

10″ M.L.R. of 18 Tons, Casemate Platform. Mark I.

10″ M.L.R. of 18 tons casemate platform, Mark I. (low). (See R.C.D. photolithographs, 133 and 133A.)

This platform consists of two sides, five transoms, two truck plates, one top plate, four flanged feet, and four trucks.



Construction.

The sides (see Fig.) are made "fish-bellied" in form in order that the strength of each portion may be proportionate to the strain which it has to bear. This form necessitates each side being "built up," which is done by riveting two pieces of ¾″ plate of the required shape to two pieces of tee iron 6¾″ wide in the tee. The upper tee iron is straight and forms the upper surface of the side, the under one bent to correspond to the fish belly of the plates, which latter lie upon the webs of the former. The webs touch each other in front, the depth of the side there being 6½″, in rear they do not, but have a packing piece between them, the depth being 11½″: in the middle the greatest depth is 18″. When the upper surface of the side stands at 4°, the ends are vertical: the interior surfaces of the parts are painted with Pulford's black, before being riveted together, and when complete the side is planed in the usual manner.

The front transom is of 1″ plate, with a piece of angle iron riveted along the upper edge and another piece along the lower edge.

The second transom is of 1¼″ plate, riveted to a three-sided frame of angle iron; the plate has a circular hole in the centre for the end of the piston rod to enter when the carriage is run up.

The third and fourth transoms are each of 1″ plate riveted on three sides to a frame of angle iron.

The fifth transom is also of 1″ plate, with angle iron riveted all round except where a space is left at the upper edge to admit of the cap of the buffer, when the transom is in position, bearing against the plate.

The top plate and truck plates are each 1″ in thickness.

The flanged feet, both front and rear, are formed in the same manner as the front in the 7″ and 9″ casemate platforms, that is, the flanges unconnected, and the trucks are similar to those of the latter platforms. The front trucks are 10″ in diameter and the rear 13″, and instead of being cylindrical are for the future to be coned* to suit the pivot.

The front transom, its angle iron being on the inner side, is secured between the front extremities of the sides by iron knees which are bolted to the sides and to itself. The second transom is slightly let into the sides, 1′ from the front. The top plate lies over the front transom and sides and upon the angle iron of the second transom, and is bolted to all. The third and fourth transoms rest upon the lower tees of the sides, and are bolted to the latter, respectively at 4′ 8″ and 8′ 4″ from the front. The fifth or rear transom is let into and bolted to the sides 4¼″ from their rear extremities; this as well as all the other

* To run on steel racers; approved for 10″ and upwards.

transoms stand vertical when the sides of the platform are at the correct slope. The front truck plate is bolted beneath the front of the sides, and the rear truck plate 10¼′ more to the rear, angular packing pieces being placed between the latter and the sides. The flanged feet are bolted beneath the truck plates at the correct set to suit the "A" pivot and the trucks secured in them on 3″ axles by double nuts.

Fittings.

The platform has the following fittings, namely,—*

Foot planks, two on each side of the buffer, the outer 9″ wide, and the inner 7½″, attached to supporting blocks, which rest upon and are bolted to the angle iron of the fourth and rear transoms.

A stop for the carriage when run up, formed in the same manner as in the 7″ and 9″ platforms, but with five buffers, the indian-rubber rings of which are 2½″ thick, and their spindles 8½″ long.

Stops to receive the carriage on recoil, placed 2′ 11½″ from the rear extremities of the sides; the spindles of the indian-rubber rings of these are 6″ long.

Eye bolts and staples for the side arm brackets, as in the 7″ and 9″ platforms. The brackets in front are the same length as those in rear, viz., 9½″.

Axletree bands are bolted, one under each side immediately in front of the rear truck plate, to take the transporting axletree, while the loop for the pintail of the dilly is bolted to the front transom.

The fittings for the hydraulic buffer are, a front bearing plate of angle iron, which is riveted to the top of the fourth transom, and a rear bearing plate of plate iron riveted to the rear transom. The holding-down bands are the same as those of the 7″ or 9″ platforms, as is also the staple for the spanner. The holes in the piston of the buffer are ·8″ in diameter.†

The traversing and running-back gear, handles at the side, is similar in its parts and working to that of the 9″ casemate platform, but the number of teeth in the spur wheel is 62, in the bevel portion of the double pinion which gears into the pinion of the cross shaft 27, and in the latter pinion 15. The gain of power in traversing is 40 : 1, and in running back, exclusive of the sheaves, 41 : 1.

The traversing and running-back gear, handle at the rear, is similar to the corresponding 9″ gear, but to increase the gain of power, an additional spur wheel and pinion are introduced; these are cast in one and secured upon a spindle by a collar and hexagonal nut. The driving pinion has 12 teeth and gears in this intermediate wheel, which has 46 teeth; the pinion of the latter has 12 teeth, and gears in the spur wheel of the shaft, which wheel has 46 teeth. The bracket of the spindle of the driving pinion is of metal and in two parts, as in the 9″ gear. The gain of power in traversing is 50 : 1 and in running back 52 : 1.

10″ M.L.R. of 18 Tons, Casemate Platform. Mark II. (High.)

10″ M.L.R. of 18 tons, casemate platform, Mark II. (high.) (Plate XV.)

This platform is constructed for the 10″ carriage, Mark II. (low), and to make up for the lowness of the brackets of that carriage is made of greater height than the ordinary casemate platform, Mark I.

Construction.

The frame of the platform is the same as that of Mark I., except that in consequence of the well of the carriage extending down between the

---

* In future 10″ platforms, and upwards, will have two snatch blocks for loading tackle attached to the top plate.

† The cap of the hydraulic buffer for the 10″ gun and upwards will in future be of wrought instead of cast iron. The plug for the buffer when used in the 10″ platform, Mark II., is special.

sides, the third transom is removed and the fourth moved to the rear, to within 2′ 5″ of the rear extremity of the platform. A bottom plate is also added, extending from this transom to the rear.

To raise the frame to the necessary height 18″ trucks are used both in front and rear, and packing pieces placed between the sides and the truck plates, those over the front truck plate being rectangular, and over the rear angular.

Fittings. In consequence of the form of the carriage the buffer has to lie very low between the sides of the platform; it is therefore supported in rear in a solid forging bolted beneath the bottom plate, and strengthened by stays; in this bearing it is secured by two pieces of angle iron held, each by a bolt nutted in rear. A bearing for the front of the buffer is formed by pieces of angle iron riveted together, and bolted across beneath the sides; upon this the buffer is secured by a band in the usual way.

The indian-rubber buffers, which form the stops for the carriage when run up, are fixed to the second transom, those for the carriage on recoil to the rear transom but one. The platform has no foot planks.

The traversing and running-back gear, which is worked by two side handles, is similar to the casemate platform, Mark I., but the longitudinal shaft instead of lying central is to the left, to clear the buffer, which necessitates the right truck shaft being longer than the left.

The parts are as follows :—

Two cast-iron bevel wheels for hind trucks, 25 teeth.
Two truck shafts, $2\frac{3}{4}$″; the right the longer, and with collar and screw.
One cast-iron bevel pinion, 17 teeth, with key, for right of right truck shaft.
One cast-iron bevel pinion, 27 teeth, with key, for left of right truck shaft.
One cast-iron double pinion, with key, for left shaft, 17 teeth on portion which gears in truck, 27 on that which gears in clutch.
One shaft, $2\frac{1}{2}$″, with collar and screw.
One metal clutch for shaft, 27 teeth.
One spur wheel of cast iron, 65 teeth, with key to secure it on shaft in rear of the rear bracket.
One bollard with two keys for same shaft.
One spindle with collar and hexagonal nut.
One cast-iron double pinion, 13 teeth on spur portion, 27 on bevel portion.
One cross shaft, 2″, with two collars with screws and two winch handles of 17″ radius.
One cast-iron pinion, 15 teeth, with key for cross shaft.
One double and one single block.

The truck shafts are held in brackets of the usual form bolted under the truck plate, the centre bracket also serving for the front of the longitudinal shaft. The latter shaft is also held in two brackets bolted under the bottom plate. The bearings for the spindle and for the cross shaft are bolted to the rear transom, to which is also bolted the shell of the single block; the double block is movable, when in use being attached to the same transom.

The gain of power in traversing is 4 : 31, and in running back, without reckoning the sheaves, 32 : 1.

10″ M.L.R. of 18 Tons, Dwarf Platform, "A" Pivot. Mark I.

10″ M.L.R. of 18 tons, dwarf This platform is the same as the casemate 10″, Mark I., in general construction, but raised to the requisite height by means of a sabicu

platform, "A" pivot, Mark I.

block with plate and packing pieces over 18″ trucks in front, and knee stays over 24″ trucks in rear. The flanges of the feet are not connected either in front or rear.

The fittings of the platform are the same as in the casemate, except that a side step is added on each side, hooked to staples for the purpose. The steps are 9′ 2″ long, by 10″ wide.

The traversing and running-back gear with handle at the rear is on a similar plan to that of the 9″ or 10″ casemate; the wheels and pinions are as follows :—

Truck wheels, 35 teeth.
Pinions which gear in the truck wheels, 15.
Clutch, which is of cast iron, metal bouched, 21.
Pinions on the truck shafts in which the clutch gears, 24.
Spur wheel, which is placed to rear of the shaft bracket, 46.*
Spur pinion, 12.*
Spur wheel to drive foregoing, 46.*
Spur pinion in one with previous wheel, 12.*

To form a support for the front brackets for the spindles, a plate is fitted across the platform in front of the rear transom, and strengthened by two pieces of tee iron from itself to the transom.

A few platforms have been fitted with gear set in motion by side handles, similar to that of the 9″ or 10″ casemate gear, handles at the side ; it is the same as the preceding in the truck wheels, truck shafts with their pinions and the clutch lever: the spur wheel has 62 teeth, its driving pinion 10, the bevel pinion on the same spindle with the previous 27, and the bevel pinion of the cross shaft 15. The cross shaft instead of projecting to the rear of the platform lies under its sides, so that instead of there being one pinion, a double one between the spur wheel and pinion of the cross shaft, there are two on the same spindle, a spur pinion to gear in the spur wheel and a bevel pinion to gear in the pinion of the cross shaft.

10″ M.L.R. of 18 Tons, Dwarf Platform, "C" Pivot. Mark I.

10″ M.L.R. of 18 tons, dwarf platform, "C" pivot, Mark I.

This is the same as the dwarf "A," but with knee stays between the sides and truck plates, and 24″ trucks both front and rear. As an actual pivot can be used in this case, a pivot plate is placed from the third to the fourth transom and bolted to them; in the centre of the plate is a hole for the pivot bolt.

The traversing and running-back gear with which the platform is fitted is similar to that of the "9″ dwarf C."† The number of teeth in the wheels and pinions are as follows :—

Truck wheels, 35 teeth.
Double pinion, metal bouched, 15 on each part.
Bevel pinions of long shaft, 15.
Spur pinion of long shaft, 27.
Cast-iron clutch, metal bouched, 23.
Spur wheel, 62.
Pinion which drives spur wheel, 11.
Bevel pinion on same spindle, 15.
Bevel pinion of cross shaft, 15.

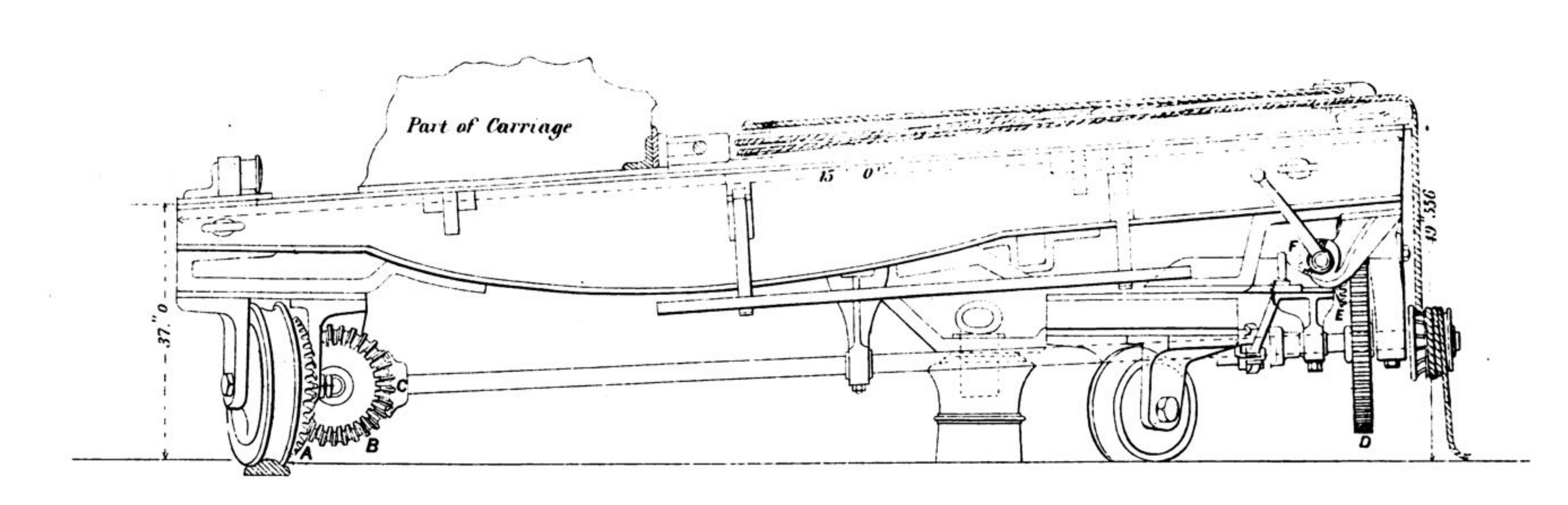
---

* As in casemate.

† As stated with regard to the 9″ platform, this gear is approved only for emplacements not requiring more than 150° of training ; a new design to govern future manufacture of 10″ platforms, "C" pivot, is in hand similar to that described for the 11″ dwarf "C."

TRAVERSING AND RUNNING IN GEAR FOR 10$^{IN.}$ DWARF PLATFORM D^{r} "PIVOT"

SCALE. ABOUT $\frac{1}{28}^{TH}$ FULL SIZE



10″ M.R.L. of 18 Tons, Dwarf Platform, "D" Pivot. Mark I.

10″ M.L.R. of 18 tons, dwarf platform, "D" pivot, Mark I. Plate XXI. (See also R.C.D. photo-lithographs, 136 and 136a.)

This is the same as the "C" pivot platform, except that it has 18″ trucks in rear and a sabicu block with plate and angular packing pieces between the sides and the rear truck plate, and to suit the position of the pivot, the pivot plate placed from the fourth transom to the block.

The traversing and running-back gear is the same as in the 9″ D platform, except that the number of teeth in the different wheels and pinions varies, viz. :—

Truck wheels A, 35 teeth.
Bevel pinion B, to gear in right truck wheel, 30.
Mitre pinion of truck shaft, 30.
Double pinion, metal bouched, 30 on each part.
Mitre pinion C, of long shaft, 16.
Spur wheel D, 62.
Double pinion E, 12 teeth in spur part, 35 in bevel part.
Pinion F, of cross shaft, 15.
Gain of power in traversing, 39·25 : 1 ; in running back, 42·75 : 1.

11″ or 12″ M.L.R. of 25 Tons, Casemate Platform. Mark I.

11″ or 12″ M.L.R. of 25 tons, casemate platform, Mark I. Plate XXII. (See also R.C.D photolithographs, 137 and 137a.)

The construction of this platform is the same as that of the 10″ casemate, Mark I., but underneath the ends of the sides and rear transom a bottom plate is bolted, a piece of angle iron being riveted along the back of the transom for attachment to the latter, and also a diagonal stay with two arms is placed between the third and fourth transoms. The greatest depth of the side is 20″, its depth in rear 11½″, and in front 8¼″, while the width of the tees is 6¾″.

The brackets for the side arms and spindles of the buffer stops are the same as in the 10″ platform.

If fitted for the Elswick compressor, the fitments are the same and interchangeable with those of the 9″ platform. When so fitted, the foot planks are 15″ wide, and the short planks between the fifth and sixth transom 6″ wide. These platforms, as just mentioned, had six transoms, of which, when they are altered to take the buffer, the fourth from the front is removed. In addition to this alteration and removing the bars, &c., the top and bottom angle iron of the rear transom have to be cut to allow of the buffer bearing against the plate, a hole to admit the piston rod has to be made in the second transom, and the top of the fourth slightly hollowed out, when the usual fitments for the buffer are added.

If the platform is fitted for the buffer, the foot planks are 10½″ wide, two on each side. The fitments are interchangeable with those of the 10″ platforms, except the buffer itself, in consequence of the holes (four) in its piston, being ·9″ in diameter.

Before the introduction of running-back gear, this platform was fitted with two bollards, one on either end of the rear transom.

The traversing and running-back gear, handles at the side, is similar to the gear of the 10″ casemate, Mark I., but to increase the gain of power an additional pinion and wheel, cast in one, are introduced between the spur wheel and the driving pinion on the cross shaft.

The wheels and pinions are as follows :—

Two metal bevel wheels A, 17 teeth, for hind trucks.
Two cast-iron pinions B, 17 teeth, to gear in truck wheels.
Two mitre pinions, cast iron, 16 teeth, in which clutch gears.
One metal clutch pinion C, 16 teeth.
One spur wheel D, cast iron, 62 teeth.

One intermediate pinion and wheel E, of cast iron, in one, 13 teeth on the pinion, 46 on the wheel.
One double pinion of cast iron, 13 teeth on the spur portion, 19 teeth on the bevel portion.
One bevel pinion for the cross shaft, 19 teeth, of cast iron.

A treble block is used, instead of a double as in the 10″ platform, which is bolted to the back of the rear transom, the single block being also bolted to the same. The shafts, except the cross shaft, which is 2″, are 2¾″ in diameter, and the radius of the winch handle is 16″. The gain in power in traversing is 48 : 1, and in running back, 56 : 1.

The gear set in motion by one handle at the rear is the same as the foregoing, except that a spur pinion F, held on a spindle in a metal bracket, takes the place of the double pinion, while the cross shaft and its pinion are not required. The spindle of the pinion is supported in a metal bracket bolted to the rear transom. The gain of power is as before.

11″ or 12″ M.L.R. of 25 Tons, Dwarf Platform, "A" Pivot. Mark I.

11 or 12″ M.L.R. of 25 tons, dwarf platform, "A" pivot, Mark I.

The frame of this platform is the same as the last described, and it is raised to the required height in the same manner as the 10″ dwarf A. It has not yet been fitted with traversing and running-in and out gear, but a drawing has been sealed to govern future manufacture, handle at the rear, the wheels and pinions of which are as follows:—

Truck wheels, 35 teeth.
Pinions which gear in truck wheels, 15.
Clutch, metal, 16.
Bevel wheels on truck shafts, in which the clutch gears, 22.
Spur wheel on longitudinal shaft, 62.
Spur pinion on spindle, to drive spur wheel, 14.
Spur wheel, in one with previous pinion, 46.
Spur pinion, to drive previous spur wheel, 14.
The gain of power in traversing is 69 : 1, and in running back 52 : 1.

11″ or 12″ M.L.R. of 25 Tons, Dwarf Platform, "C" Pivot. Mark I.

11″ or 12″ M.L.R. of 25 tons, dwarf platform, "C" pivot, Mark I. Plate XXIII.

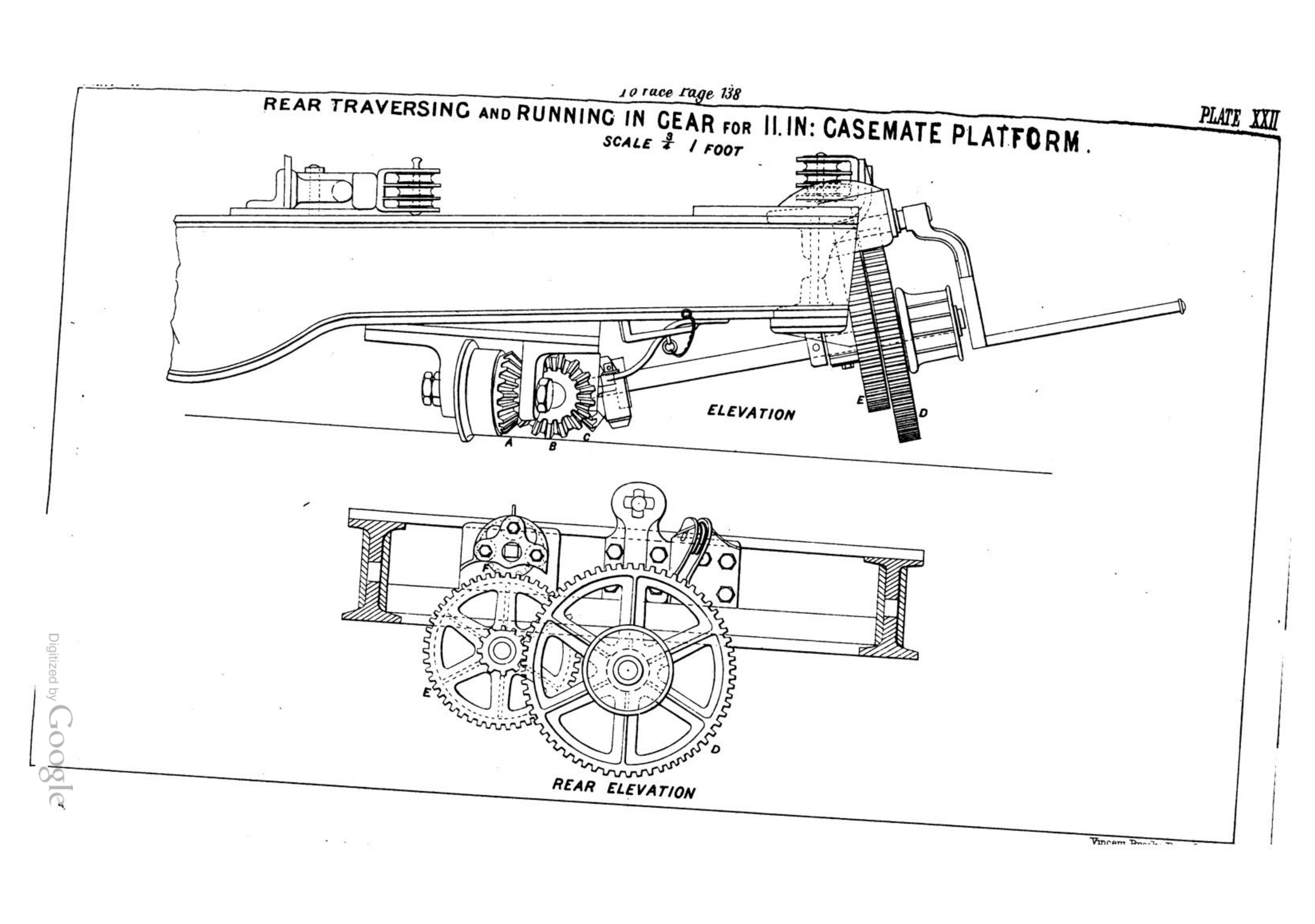
This platform corresponds to the 10″ dwarf C, and is fitted with traversing and running-in and out gear similar to the latter and the 9″ dwarf C.

The wheels and pinions are as follows:—

Truck wheels A, A, 35 teeth.
Double pinion B, metal bouched, for truck shaft, 15 on each part.
Bevel pinions C, C, of long shaft, 15 each.
Spur pinion D, of long shaft, 32.
Clutch spur pinion, metal bouched, 19 teeth.
Spur wheel, 62.
Spur pinion which drives spur wheel, 11.
Bevel pinion on same spindle as last, 15.
Bevel pinion of cross shaft, 15.
A treble block is used in the running-back gear.

In future the driving cross shaft is to be nearer the pivot, instead of at the extremity of the platform. The longitudinal shaft with its

To face Page 138



To face page 139

TRAVERSING AND RUNNING IN GEAR, "CENTRAL" (MARK I) FOR 11 IN. DWARF PLATFORM "C" PIVOT

SCALE ¼ INCH FOR A FOOT

pinions &c., remaining the same, the remainder of the gear will then be as follows :—

Short longitudinal shaft F with collar and pin.
Metal clutch E with lever, to fit on short shaft and gear in spur pinion on end of long shaft.
Face wheel G with key, to fit on front extremity of short shaft.
Spur wheel H, with bevel pinion, the latter to gear in previous face wheel.
Spindle with screw, collar and nut, for spur wheel.
Cross shaft I with spur pinion K to gear in spur wheel.

For driving bollard :—

Spur pinion L with key on rear of short shaft.
Spur pinion M with key on bollard spindle to gear in previous.
Gain of power in traversing, 66 : 1 ; in running back, 47 : 1.

The short longitudinal shaft is supported in two brackets, one attached to the rear transom, and one to the rear truck plate. The spindle of the spur wheel with pinion is held in a bracket bolted to the rear truck plate, and the bollard spindle in a bracket bolted to the transom. The cross shaft passes through metal bearings bolted in the sides of the platform about 6′ from the rear.*

11″ or 12″ M.L.R. of 25 Tons, Dwarf Platform, "D" Pivot.

11″ or 12″ M.L.R. of 25 tons, dwarf platform, "D" pivot.

Has not yet been constructed; a drawing of traversing gear, handles at side, has however been sealed, to govern future manufacture, the wheels and pinions of which are as follows :—

Truck wheels, 35 teeth.
Pinions which gear in truck wheels, 15; the left of these pinions is double, having 30 teeth on its other part, and is metal bouched.
Centre pinion on truck shaft, 30.
Pinion on front of long shaft, to gear in centre and double pinion, 16.
Metal clutch on rear of long shaft.
Iron clutch on front of short shaft, to gear in previous.
Spur wheel on short shaft, 62.
Spur pinion on spindle, to drive spur wheel, 12.
Bevel wheel on same spindle, 35.
Bevel pinion on cross shaft, to drive bevel wheel, 15.
Gain of power in traversing, 69 : 1 ; in running back, 42·75 : 1.

†12″ M.L.R. of 35 Tons, Casemate Platform. Mark I.

12″ M.L.R. of 35 tons, casemate platform, Mark I.

Construction.

The general form of this platform is the same as that of the 12″ of 25 ton, casemate; the depth of the sides in front is 9½″, in rear 14¼″, and at the centre 20″, while the width of the tee is 6¾″.

The rear transom is of 1″ plate riveted to a frame of angle iron; it is bolted in the usual way between the sides with a bottom plate beneath. The front and second transoms are much deeper in the middle than the sides, in fact their lower part is semi-circular, as the second has to be cut away to allow of the buffer bracket of the carriage passing it, and the front has a hole in it to prevent the end of the piston rod striking it. The plate of the front transom is 1″ thick, and of the second 1½″, each

---

* Platforms with "central" gear have a short wood step, and an iron step at each side, instead of one long wooden one.

† Experimental.

being riveted to an angle iron frame. Over these transoms the head plate, which is also slotted on account of the buffer bracket, is secured, and beneath them and the sides a 1″ truck plate, the latter being bent to correspond to their form. To the rear of this truck plate and touching it, a second truck plate is bolted to the sides; it is slightly bent in the centre to clear the buffer bracket. The flanges of the front trucks are bolted in the usual way beneath these trucks.

The rear truck plate is placed a few inches to the front of the bottom plate, and has packing pieces between it and the sides.

The third and fourth transoms are formed in the usual way, the latter recessed to support the front of the buffer, and the former cut away for the carriage bracket to pass.

Fittings.

The buffer is secured in the usual manner, it is 1″ shorter than the ordinary 7″ to 12″ buffer, its piston rod is 3″ in diameter, its holes $\frac{7}{10}$″, and its caps of wrought iron.

The traversing and running-back gear is as follows :—

Three trucks are placed in gear, the two rear and the left front, a metal bevel wheel being attached by screws to each. They are each driven by a truck shaft which has a bevel pinion gearing in the truck on the outer end, and a mitre pinion on the inner.

The truck shafts are driven by a long longitudinal shaft, central beneath the platform, two clutch pinions moved by levers on the left being placed upon it, the front to gear in the mitre pinion of the front truck shaft, the rear into the mitre pinions of the rear truck shafts.

The long shaft has a mitre pinion on it to the rear of the rear clutch in which a pinion on a short cross shaft, parallel and to the rear of the right truck shaft, gears. This cross shaft has a spur pinion on it which is driven by a similar pinion on another cross shaft placed under the sides between the bottom plate and the rear truck plate; to increase the gain of power these pinions do not however gear directly into each other, but into an intermediate double spur pinion running loose upon the right truck shaft. The cross shaft has a spur wheel upon each extremity outside the side of the platform, and each spur wheel is driven by a spur pinion and winch handle. The pinions and wheels have metal guards over them.

The bollard is keyed upon the end of the long shaft; a single leading block is held in a bearing bolted to the rear transom to guide the fall to the bollard, and two single sheaves are secured between the bridge piece and the transom, through which and the snatch blocks on the carriage the fall is rove.

* 10″ M.L.R. Howitzer of 6 Tons, Platform.

10″ M.L.R. howitzer of 6 tons, platform.

The platform designed for the 10″ rifled howitzer is similar to the 10″ M.L.R. gun platform, Mark II., and is formed of two fish-bellied sides 13″ deep in front, and 18″ in rear, with upper tee 6″ wide, and lower $6\frac{1}{2}$″, connected by two transoms and a truck plate in front, a transom and truck plate in rear, by a pivot plate in the centre, and also by a diagonal stay similar to that of a 9″ M.L.R. platform.

The flanges of the feet for the trucks are connected by a plate; the front feet are bolted direct to the truck plate and sides, and over the rear feet between the truck plate and sides wedge-shaped packing pieces are placed. The trucks are 18″ in diameter, both front and rear.

---

* Designed only.

The hydraulic buffer with which the platform is fitted is secured in the usual manner upon a rear bearing plate attached to the rear transom and upon a front bearing plate attached to the diagonal stay; it is the service buffer 7″ to 12″.

The platform is fitted with sabicu foot planks, and the ordinary stops for the carriage, the rear stops allowing of a recoil of 4′ 5½″ before compressed.

CHAPTER IX.—MONCRIEFF CARRIAGES AND THEIR PLATFORMS.

The principles upon which Major Moncrieff has constructed his garrison carriages may be said to be twofold, namely:—

First. To afford cover to the gun detachment by enabling the gun when run up to fire over a solid parapet, though when run back to be in a low and convenient position for loading, and entirely protected from view and from direct fire.

Second. To store up the force of recoil and utilize it for bringing the gun from the loading to the firing position.

In general terms we may say that Major Moncrieff carries out these principles by using a level traversing platform, and placing the gun, and its carriage proper, in a carriage, termed an "elevator," which rolls upon the platform, and which in so doing, from its peculiar form, places the gun in the required position either for loading or firing. Further, he weights the opposite end of the elevator to that in which the gun lies, so that as the force of recoil causes the elevator to roll to the rear and the gun to descend, it at the same time raises the weight. The latter being thus placed in an elevated position has a certain amount of energy stored up, as it were, in it, which energy, as soon as the weight is permitted to fall, is expended in raising the gun to the firing position again, the elevator rolling to the front.

In fact the elevator may be regarded as a lever of the first order, the gun at one extremity and the weight at the other; and here it is to be noticed, first, that the fulcrum on which the elevator rests is not fixed, but movable or changing, whereby any jar or concussion to the parts on discharge is avoided, at least in a horizontal direction; second, still further to ensure against any such jar, the curve of the rolling surface of the elevator is such that on discharge and during first motion, the latter moves freely, the counterweight not taking up much of the force of recoil. In fact, the elevator rolls about half the length of the platform before the leverage of the counterweight or resistance increases much. For the remainder of the length of the platform the curve is such that the counterweight acts with a rapidly-increasing leverage, while that of the gun or force of recoil diminishes, so that the latter is more and more absorbed until finally the gun comes to rest.

"That there may be no dead point or tendency to run back in some positions, if checked, in rising from the loading to the firing position, as is necessary to prevent the mass running up violently, the apparently quadrantal part of the elevator is in reality an arc of the involute of a small circle described round the common centre of gravity of the gun carriage and elevator, or rather round the projection of that centre on each side of the elevator."—*Rev. James White, M.A. See Proceedings, R.A.I., No. 5, Vol. VIII.*

There are two patterns of Moncrieff carriages; in the first the gun is placed in a carriage distinct from the elevator, in the second the elevator itself carries the gun.

Table.

Nature.	Mark.	Weight.*				Tonnage.	Height of Axis of Trunnions.			
		Part.	tons.	cwts.	qrs.	Tons.	Firing position.		Loading position.	
							ft.	in.	ft.	in.
7″ M.L.R. of 7 tons -	I.	Carriage	1	14	0	—	†11	0	7	1
		Elevator	14	17	0	—				
		Platform	5	12	2	—				
„ „ -	II.	Elevator		—		—	‡12	$3\frac{1}{2}$	5	8
		Platform		—		—				
7″ B.L.R. of 82 cwt. -	II.	Elevator	8	19	2	—	10	$5\frac{3}{4}$	5	$1\frac{1}{2}$
		Platform	4	3	1	—				
64-pr. M.L.R. of 58 cwt.	II.	Elevator	8	1	2	—	10	5	4	$9\frac{1}{2}$
		Platform	3	15	2	—				
9″ M.L.R. of 12 tons -	II.	Elevator	26	7	0	—	14	0	6	$11\frac{1}{2}$
		Platform	13	1	0	—				

* With gear. † To fire over a parapet $9\frac{1}{2}'$ or 10′ high. ‡ To fire over a parapet 11′ high.

7″ M.L.R. of 7 Tons Carriage. Mark I.

The Carriage proper.

7″ M.L.R. of 7 tons carriage. Mark I. (See R.C.D. photo-lithographs, 60A and 60D.) The carriage proper.

The carriage A is formed of two brackets connected by two transoms. The brackets are nearly triangular in shape, and are each composed of a wrought-iron frame $3\frac{1}{2}''$ wide, with a $\frac{1}{2}''$ plate riveted on either side. In the upper part is the trunnion hole fitted with a metal bearing plate and a capsquare secured by clips with screws and bolts; in the lower part to the front is a metal-bouched hole to receive the shaft which connects the carriage to the elevator, while in the rear a wrought-iron axle is secured. The latter passes from one bracket to the other, and has near its extremity, outside each bracket, a wrought-iron truck with securing collar. The axle has a piece of angle iron bolted along its upper surface and another piece along its under side; it is secured to each bracket by two knees and a stay.

The transoms are of plate connected by means of angle iron to the brackets; the front is placed vertically, the rear horizontally.

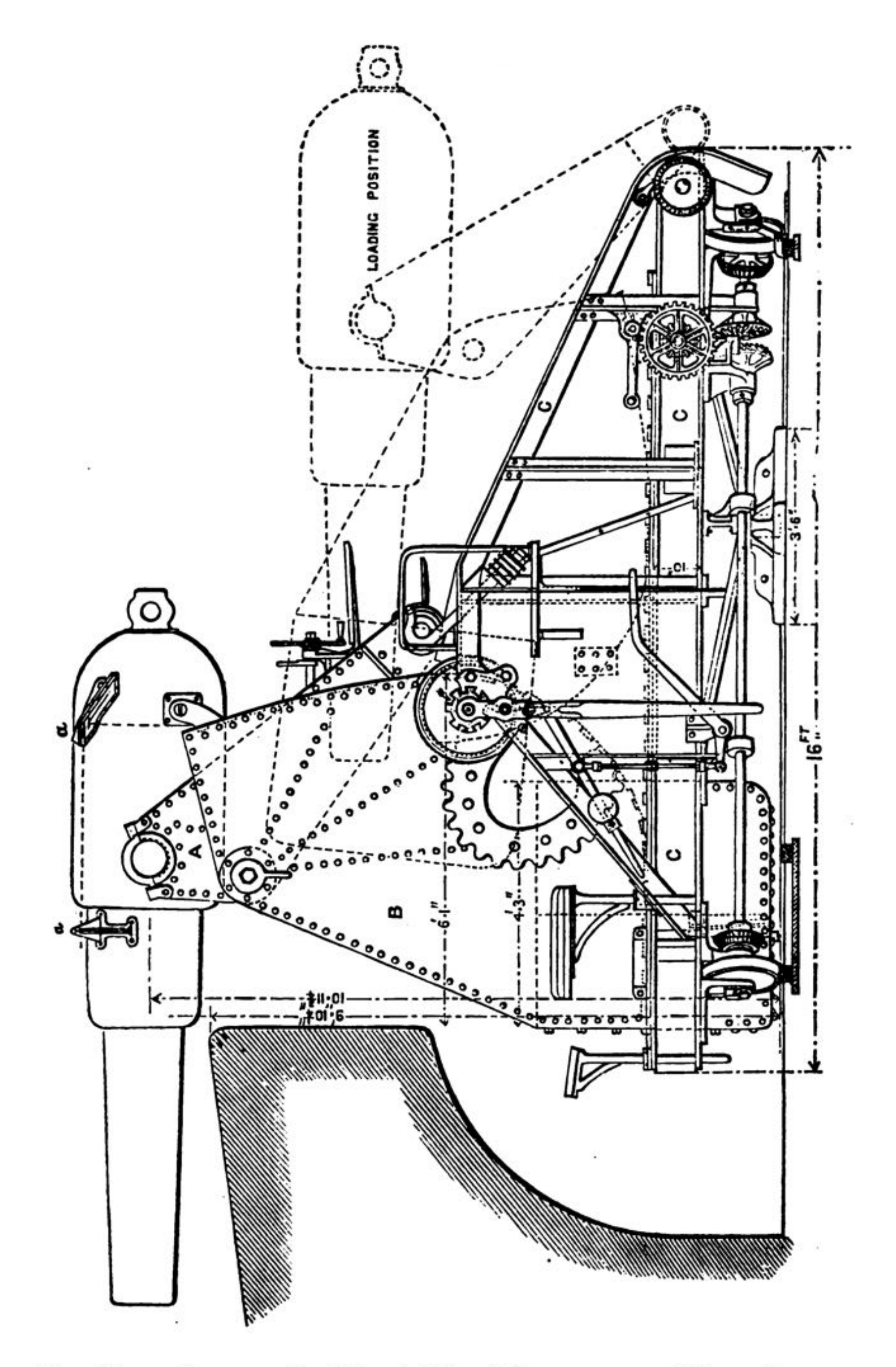
The second or rear transom supports the elevating arrangement, which consists of the following parts, namely:—

One shaft.
Two pinions.
Two elevating arcs.
Two clips.
Two nuts.
One worm wheel, comprising two friction cones and one metal band with teeth.
One worm shaft with two hand wheels and a locking handle.

The elevating arcs are pivoted to the gun in the usual manner, and the right-hand arc is graduated with degrees, a pointer being fixed upon the bracket by which to set it.

The elevating shaft rests in metal bearings in the brackets and in a third bearing bolted to the transom. The pinions upon this shaft gear in the elevating arcs, the latter being kept in position by the clips. On the right of the shaft is the worm wheel, which is worked by the worm

shaft, the latter being supported in metal bearings, one on the front transom and two on the rear transom.



To allow of some slip (about 20) of the arcs on firing, the worm wheel is made composite, in a similar manner to that in Mark II., to be hereafter described. The locking handle is placed upon the rear of the worm shaft; turning it presses a nut against a collar on the shaft and prevents the latter moving, and consequently the worm wheel, on firing.

A laying stage is attached to the rear transom, and a step to mount to it to the rear of each bracket.

The Elevator.

The elevator.

The elevator B, consists of two sides connected at the lower part by wrought-iron boxes, which contain the counterweight, and at the upper part by a transom.

The sides are formed in the same manner as the brackets of the carriage; their rear edges or surfaces are curved, and have teeth formed on them to guide the elevator in its rolling upon the platform and to prevent slip. The counterweight boxes (three, two side and one centre) are bolted between the sides in such a manner that when the gun is raised to the firing position they lie between the sides of the platform. These boxes are packed with pieces of cast iron and wood of sufficient weight to raise the gun from the loading to the firing position without a dead point. In the upper part of the elevator are metal-bouched holes to receive the main shaft which connects the carriage to it. Upon the extremities of the shaft outside each bracket is a loop washer secured by a screw.

A cycloidal rack is bolted to each side of the elevator for pinions on the platform to gear into, by which the elevator can by hand be moved to any position.

A shot guide is bolted upon the lid of the centre counterweight box to facilitate loading.

The Platform.

The platform.

The frame of the platform C, consists of two sides connected by four transoms, a cross stay and a pivot stay, and fitted with flat-soled trucks in flanged feet. Fixed upon the sides of the frame are guides for the trucks of the carriage to run on, and also walls to support brake gear, &c.

The sides are of girder iron and are straight throughout their length; they are 16′ long, and placed so as to be $5\frac{1}{2}'$ from outside to outside.

The second and third transoms are of plate riveted to angle iron; the front and rear are of plate only, the latter placed horizontally; all four transoms are bolted between the sides, the first and second being strengthened by long knees.

The cross stay is of girder iron, and is bolted beneath the sides $9\frac{1}{2}'$ from the front.

The pivot stay is a diagonal stay of plate iron; its centre, to which a pivot socket is attached, is bolted under the centre of the cross stay and its arms under the sides.

The flanged feet are bolted beneath the sides, those in front projecting outwards; two have metal bearings for the axles of the trucks. The latter are of wrought iron, 16″ in diameter, and their axles are of steel.

The guides are of angle iron, and stand one along each side, supported by stays of tee iron.

The walls are of plate, each in the form of a box open at the top and the bottom, extending from the top of the highest part of the guide to the lower edge of the side. They are riveted to four of the stays of the sides, and are supported also by a piece of tee iron fixed across and under the platform.

A guide rack to guide the elevator in its motion is fixed along the upper surface of each side; it has teeth in it corresponding to those in the elevator, and a stop at each end.

Brake gear, for the purpose of holding the elevator down after recoil and controling its rise, is fitted on each side of the platform. It consists, on each side, of a shaft supported in metal bearings on the upper

part of the wall; on the inner end of the shaft there is a pinion gearing in the cycloidal rack of the elevator, on the centre a brake wheel, towards the outer end a ratchet wheel, and on the outer extremity a socket to receive an iron-pointed lever. *The brake wheel with the gear connected with it is similar to that of Mark II., to be presently described.

A sliding locking plate is bolted on the front of each wall to secure the gun when left standing in the loading position: to use the bolt its retaining screw is withdrawn and it is allowed to drop on the short arm of the bent lever, in which position it is secured by its screw; it acts by preventing the arm rising and the friction band being thereby loosened.

A loading stage on two supporting bars is fitted across the breast of the platform, and two others, one on each side, near it, for the numbers loading the gun; the latter are pivoted each on a single supporting bar, so that they can swing clear of the elevator as the gun rises to the firing position.

Two other stages, with guard irons and ladders to ascend by, are fitted one on each wall of the platform.

A preventor hook with india-rubber washers, separated by plates, is supported in a cast-iron socket bolted to the top of the rear of each wall. The hooks catch the points of the axletree arms of the carriage and arrest the latter when run up.

A bollard is fitted on each side of the platform in rear, to take, on emergency, a preventor rope led from the loop washer on the main shaft of the elevator. On the inner side of the bollard there is a ratchet wheel in which a pawl, pivoted on the guide, drops, so that the bollard can only turn in one direction.

A pointer, consisting of a small plate of steel which fits over the racer is attached by an arm to the flange of the left rear truck, so that in firing at any fixed object the correct line of fire can readily be adhered to by marking the racer.

The platform is fitted with traversing gear, as follows:—

A long and a short shaft are held in cast-iron brackets under the left of the platform; they lie in prolongation of each other and at an angle to the side. On the front extremity of the long shaft there is a bevel pinion (14 teeth) gearing into a bevel wheel (18 teeth) on the spindle of the front truck: on the rear extremity of the short shaft there is a similar pinion gearing into a bevel wheel (26 teeth) on the rear truck; upon the other extremities of these shafts there are mitre wheels (30 teeth) facing each other. Gearing into these latter is a mitre pinion (15 teeth) on a short vertical shaft placed between them. Upon the upper extremity of this vertical shaft there is a second mitre pinion (15 teeth), which is driven by another pinion on a cross shaft. The latter passes through the sides of the platform and has upon each extremity a spur wheel which is driven by a pinion and winch handle. The spur wheels and pinions are covered by guards, and also the pinion gearing into the front truck wheel.

Painting. The interior of the counterweight boxes and of the brake drums receive two coats of red lead; with this exception, and bearing surfaces &c., which are not painted, the carriage, elevator, and platform receive two coats of lead paint, grey colour.

Mounting. The platform with its gear and trucks attached is first lifted into its place, the pivot and socket being previously greased.

---

* These wheels are not interchangeable from one side of the platform to the other, and are therefore marked R. and L.



The elevator is next placed upon the platform, care being taken that the proper teeth are in gear; blocks of wood are placed temporarily under the counterweight boxes and across the platform, so that the lids of the former are held nearly horizontal.

The carriage is then secured in position, the shaft being first cleaned and oiled.

The gun is mounted, its breech supported by a block of wood.

The counterweight boxes are packed, and finally the gear, &c. fitted on.

7″ M.L.R. of 7 Tons Carriage. Mark II.

The Elevator.

7″ M.L.R. of 7 tons carriage. Mark II. (See R.C.D. photo-lithographs, 60F and 60G.)

The elevator.

In this pattern the elevator is constructed of two double-plate sides (as in Mark I.), the frames of which, of wrought-iron, are $2\frac{1}{2}''$ wide, and the plates $\frac{3}{8}''$ thick. These are connected at the lower part by the counterweight, which is secured between them by bolts, and consists of solid blocks of cast-iron. In the upper part of the sides trunnion holes are formed and fitted with capsquares which slide into position and are secured by screws. An eyebolt to take a preventor rope on emergency is screwed into each trunnion of the gun, and as there is no transom between the sides of the elevator the gun itself is made to serve as one by placing a large washer on the trunnion secured by the eyebolt.

There are no cycloidal racks for pinions on the elevator for the purpose of retaining or controling the recoil, but instead there are what are termed "retaining racks" on the platform, to which the elevator is connected by connecting bars. One end of each of the latter is metal-bouched, and pivots on a spindle passing through part of the counterweight and the side of the elevator.

To carry the breech of the gun and also give the required elevation in laying a long elevating bar A, Fig. 1, Plate XXIV., is attached to a metal patch under the breech by a bolt, which also supports a laying stage; the lower extremity of this bar is pivoted between two radius bars B, B, one end of each of which is bent outwards and attached to a spindle in the side of the elevator, while their other extremities hold a metal roller between them. This roller runs in an elevating guide on the platform, to which the required degree of elevation is given and communicated by the elevating bar to the gun. On recoil the roller of the radius bars travels to the rear along its guide, while the elevating bar changes from a vertical to nearly a horizontal position.

The Platform.

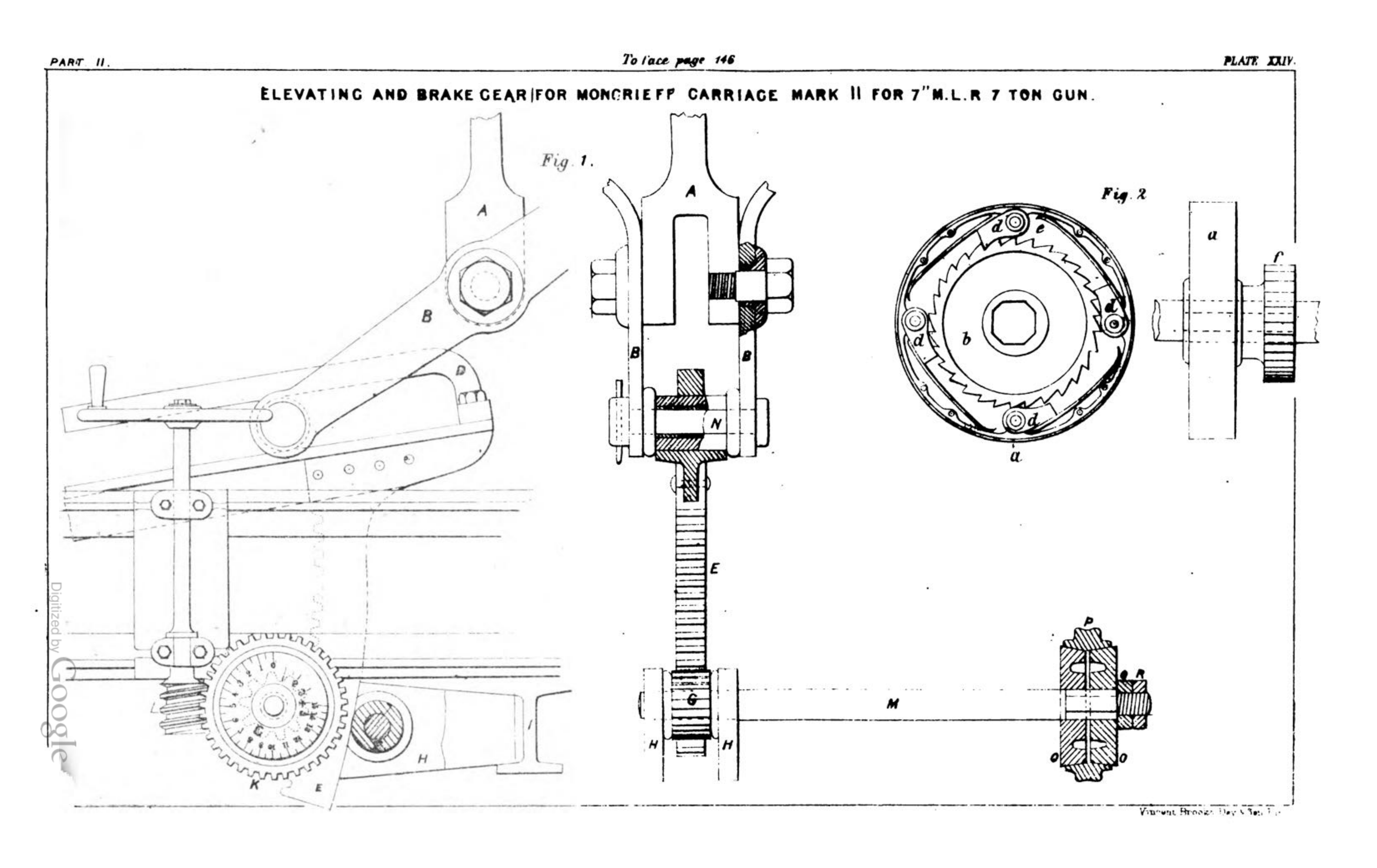
The platform.

The sides of the platform are 17′ long and placed $4' 9\frac{1}{4}''$ apart, from outside to outside; they are built up of two bars of channel iron, 1′ 2″ in depth, along which, above and below, 1″ plate iron is riveted.

Three transoms connect the sides; each is formed of plate riveted between frames of angle iron; in the front and rear transoms the frames extend all round the plate, but in the centre transom only along the sides and lower edge. The latter transom extends a little below the lower surface of the sides and not as far as the upper surface. In addition to the transoms connecting the sides there is underneath them a trough-shaped cross stay, through the bottom of which the pivot bolt passes, $10' 9\frac{5}{8}''$ from the front; this stay is strengthened by a band of plate iron passed under each end and bolted under the sides.

The flanged feet for the trucks are bolted immediately beneath the sides, and the trucks are flat-soled, of cast iron (21″ in diameter).




ELEVATING AND BRAKE GEAR FOR MONCRIEFF CARRIAGE MARK II FOR 7" M.L.R 7 TON GUN.
Fig. 1.
Fig. 2
A
B
D
E
G
H
K
M
N
O
P
R
a
b
d
e
f
Vincent Brooks, Day & Son, Lith.

A rack for the elevator to roll along is fitted on each side, and, as already mentioned, a sliding retaining rack to which the elevator is attached and by means of which its motion in rising is controlled. The rack moves upon the top surface of the side to the front, being retained on it by a wrought-iron plate fitted to the outside of the side; it is made, as it were, double, its upper surface with teeth to receive a pawl by which it and consequently the elevator can be held when left in the loading position, and its under surface with teeth for a pinion to gear into, by which it can be moved and consequently the elevator.

To facilitate the motion of the retaining racks by reducing friction, four metal rollers are fitted on the front of each rack as well as a scraper to push off any sand, &c. that might fall on the platform in front of the rollers. The pinions by which the retaining racks are worked are placed upon a cross shaft which passes through the sides of the platform and which is fitted with brake wheels, one on each side outside the platform, by means of which the elevator is held down after the force of recoil has ceased, and by which the rise of the gun again to the firing position is kept under control. A brake wheel consists, Fig. 2, Plate XXIV., of a cast-iron band (in Mark I. of metal) *a*, containing a cast-iron ratchet wheel *b*, which can move independently of the band, but must move with the cross shaft. Four pawls *d*, *d*, for the ratchet wheel are pivoted to the band, so as to act as if they were of different lengths, and are each kept from falling back too far by a spring. The ratchet wheel with its pawls are enclosed between two wrought-iron plates *e*, *e*, let into and bolted one on each side of the band.

Round the brake wheel passes a friction band of iron lined with wood, one end of which is fixed to the side of the platform and the other to a bent lever. The latter is pivoted to the platform near its bent end, while the other arm, which lies along the platform towards the rear, is weighted with a cast-iron sliding weight secured by a screw. The weight is so adjusted as to tighten the friction band sufficiently to hold the brake wheel, so that the pawls of the latter may prevent the ratchet wheel turning back and the elevator rising as soon as the force of recoil has ceased. When the weighted arm of the lever is raised, and the friction band thus loosened, the whole of the brake wheel is allowed to revolve, and therefore the elevator to rise. In order that the brakes on each side of the platform may be worked simultaneously a cross shaft is fitted through the sides of the platform to the rear, to each end of which a bent lever is attached. The counterlever of the latter is connected by a small shaft, which has an adjusting screw on each end, with the weighted lever of the friction band. Pulling the end of the bent lever to the rear raises the weighted lever and loosens the band, and not only on the side of the bent lever used, but also, by means of the cross shaft, on the other side also, if the adjusting screws are properly set.

A ratchet wheel *f*, Fig. 2, is fitted on the brake shaft outside each brake wheel, and a movable socket with pawl for the purpose of moving the elevator by hand into any required position. The pawl is double, so that it will act either way; when in gear with the ratchet wheel and the socket is worked by an iron-pointed lever, the shaft is turned and its pinion moves the elevator.

The brake drums and the pinions are covered by guards.

The elevating guide D, Fig. 1, Plate XXIV., to receive the roller N of the radius bars lies along the centre of the platform to the rear, being pivoted on a support which rests upon a piece of tee iron fitted across the platform.

To give the elevation required in laying the gun, an elevating arc E is attached beneath the front of the guide, and passes down between a

friction roller F and pinion G, by the latter of which it is worked. These are supported between two plates H fitted beneath the platform from the front of the cross stay to a piece of girder iron I riveted under the centre transom. The pinion is upon the inner end of a short shaft M, the other end of which passes through the right side of the platform, and has upon it a worm wheel K, which is worked by a worm shaft L fixed vertically on the side, and turned by a hand wheel. The worm wheel, in order to allow of some slip of the elevating arc on firing, and so reduce the shock on the parts, is made composite (as in Mark I.); it consists of two frustra O, O, Fig. 1, of a cone, placed top to top (not touching), and turning with the shaft M; over these the worm wheel proper is placed in the form of a band P. By this arrangement, when the frustra are pressed towards each other the band is tightened upon them, and vice versâ. The tighter the band is made the less will be its slip, and consequently that of the elevating arc. The frustra are pressed together, as desired, by means of a nut Q, outside of which a locking nut R is placed.

A loading stage is formed between the sides at the centre by baulks supported on angle-iron frames. In this pattern the operation of loading is much easier than in the first pattern, being performed under instead of over the counterweight. The projectile being placed upon the loading stage is hoisted to the muzzle by means of a chain over a block attached to the counterweight, and led by a leading block on the side of the elevator and another on the stage to the outside of the platform.

A stage with ladder is fixed on the left side of the platform, which is also fitted with bollards similar to those in Mark I.

Traversing gear is fitted to the platform, to the left front, and to the left rear trucks, independent of each other. It consists for each truck of a bevel wheel on the truck worked by a bevel pinion on a very short shaft, which is held in a bracket bolted on the outside of the side. The shaft has a bevel wheel on its upper extremity, into which a pinion moved by a winch handle gears.

7″ B.L.R. of 82 cwt. Carriage. Mark II.

7″ B.L.R. carriage. Mark II.

This carriage is of similar construction to that for the 7″ M.L.R. gun of 7 tons, but the sides of the platform are of girder iron 10″ deep, 5½ wide in the flange, and 15′ long; they are placed 2′ 9¼ apart. There is but one brake wheel, upon the left of the platform; the elevator is moved by iron-pointed levers working in capstan heads, one upon each end of the brake shaft; the trucks of the platform are 1′ 8″ in diameter.

64-pr. M.L.R. of 58 cwt. Carriage. Mark II.

64-pr. M.L.R. carriage. Mark II.

The 64-pr. carriage is the same as the preceding in its construction; the sides of the platform are the same in length and scantling as the preceding, but placed 2′ 2¼″ apart. This platform has but three trucks, one 2′ 0″ in diameter in rear, and two 1′ 6″ in diameter in front; none are fitted with traversing gear, but are moved as required by iron-pointed levers entered into holes in their peripheries. The gun when mounted will fire over a parapet 9′ 4″ high.

9″ M.L.R. of 12 Tons Carriage. Mark II.

9″ M.L.R. carriage. Mark II.

This carriage is constructed in a similar manner to that for the 7″ M.L.R. of 7 tons, but the sides of the platform are of girder iron 19′ 9″ long by 12″ deep, and 6¾″ wide in the flange; each side is strengthened by ¾″ plate riveted along the under flange of the girder, and by 1½″ plate along the web; the transoms and cross-stay for the pivot bolt are also of girder iron. The platform is supported upon six

trucks, each 2½′ in diameter, the centre being to the front of the pivot and set to the same radius as rear trucks are to the rear of it. Traversing gear is applied to the left front and left rear trucks, as in the 7″ platform. In the gear for moving the elevator by hand additional power is gained by introducing a pinion to drive each ratchet wheel on the brake shaft, the pawl of the lever socket acting in the pinion.

For raising the projectile in loading by means of a chain a small windlass is fitted on the inside of the left side of the platform, having a spur wheel on its spindle outside the platform, which is driven by a pinion and hand-wheel.

Beneath the centre of the platform a tray to receive the shot truck when it brings up the projectiles is fitted, and longitudinally between the sides of the platform in rear there is a tray for holding the side-arms.

The carriage is designed to admit of the gun firing over a parapet 12′ 6″ high.

CHAPTER X.—PIVOTS AND RACERS FOR TRAVERSING PLATFORMS.

I. For Wooden Platforms.

For wooden platforms. Pivots.

As already seen, the pivot or fixed point about which, as centre, a platform traverses, is varied according to the nature of the battery in which it is mounted, and the extent of ground which it is desired that the gun should cover. Thus in casemates and in open batteries where the gun fires through an embrasure it is necessary, in order to keep the embrasure as narrow as possible, to have the pivot in the embrasure, and thereby in traversing have very little lateral motion of the muzzle or chase. In open batteries where the gun fires over the parapet, and much ground has to be covered by the gun, a central or rear pivot is most suitable, the former being most convenient for a salient angle, and the latter for a face.

The pivots are distinguished by letters, and for wooden platforms are as follows :—

Nature of Pivot.	Distance from Breast of Platform.		Nature of Pivot.	Distance from Breast of Platform.	
	To Front.	To Rear.		To Front.	To Rear.
	ft. in.	ft. in.		ft. in.	ft. in.
A.	3 11½	—	D.	—	9 9
B.	0 2½	—	E.	—	11 5½
C.	—	6 9	F.	—	13 8½

The pivot may be an "actual" or an "imaginary" pivot. *Actual pivots are used for heavy guns with which compressors are used, as the 7″ B.L.R., 80 and 64-prs. M.L.R., and 10″ and 68-pr. S.B.; in other cases they are usually imaginary.

An actual pivot is formed by sinking a cast-iron post, with wrought-iron pin let into the top, in the required position.

Racers.

The racers for wooden platforms are of wrought iron, 2⅞″ wide, and 2¾″ in greatest depth, the upper surface being rounded off. They are laid "raised," *i.e.*, the upper surface not flush with but standing above the ground. Their radii are as follows :—

* In some cases the construction of the work will not admit of the "A" pivot being actual.

Nature of Pivot.	Radius.		Nature of Pivot.	Radius.	
	Front.	Rear.		Front.	Rear.
	ft. in.	ft. in.		ft. in.	ft. in.
A.	5 0	16 6	D.	9 0	3 4¼
B.	1 10	12 10	E.	10 8¼	2 2
C.	6 1	6 1	F.	12 10	2 2

II. For Wrought-iron Platforms.

The pivots are as follows:—

Nature of Pivot.	Distance from Breast of Platform.									
	To Front.					To Rear.				
	7″ of* 7 tons.	9″ of 12 tons.	10″ of 18 tons.	11″ or 12″ of 25 tons.	12″ of 35 tons.	7″ of 7 tons.	9″ of 12 tons.	10″ of 18 tons.	11″ or 12″ of 25 tons.	12″ of 35 tons.
	ft. in.	ft. in.†	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.
A. -	4 10¼	4 8⅝	6 6⅛	6 4¾	—	—	—	—	—	—
C. -	—	—	—	—	—	6 4¾	6 3¾	6 3¼	6 3⅝	—
D. -	—	—	—	—	—	10 0⅛	10 0¼	9 9⅝	9 9⅝	—
Moncrieff - I.	—	—	—	—	—	9 6	—	—	—	—
Moncrieff - II.	—	—	—	—	—	10 9⅝	12 9	—	—	—

* Or 9″ single plate.
† In 9″ casemate platforms which have the trucks moved 3″ further back this distance will be 4′ 5⅝″.

Pivots. The A pivot is imaginary,* and the C and D actual.

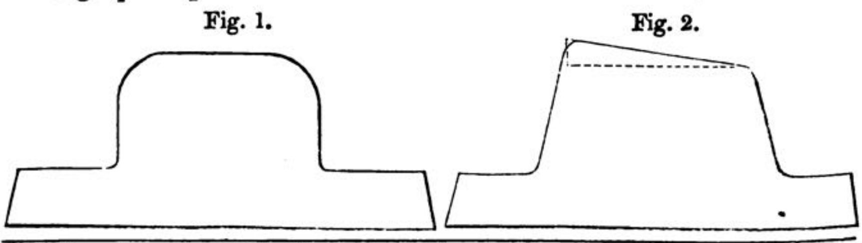
An actual pivot (except in the Moncrieff platforms) is formed by sinking a 9, 18, or 24-pr. cast-iron gun in the required position, and passing a steel pivot plug through the pivot plate on the platform into the muzzle, where it is supported on a block of wood previously placed in the bore for the purpose.

The plugs are of three natures to correspond in the diameter of the body to the bores of the guns, and weigh respectively 51, 68, and 72 lbs. The head of the plug fits the pivot hole in the platform, its diameter being the same in all, that for all platforms there may be but one size of pivot hole. The plugs are fitted each with a screw loop to serve as a handle.

The pivots for Moncrieff's platforms are formed by fixing a cast-iron pivot block upon the ground, and pinning the platform to it by a steel bolt. In Mark I. the bolt is plain, and enters a socket on the platform. In Mark II. the bolt is similar to those for the service platforms.

Racers. The racers for wrought-iron platforms have been made of wrought iron for all natures, but in future will be of steel for 10″ M.L.R. guns and upwards.

The first wrought-iron racers were of the same form and section, 2¼″ deep by 2⅞″ wide as those for wood platforms. The present wrought-iron racers, Fig. 1, are also of the same section, but with the addition of a flange ¾″ deep at the bottom at each side.



* Its position is 12″ inside the outer face of the work, and 6″ from the face of the muzzle of the gun, when the latter is run up.

Railway bar racers on Colonel Inglis's plan have been laid down in some batteries. The racer is secured in chairs, which rest on sleepers, also of railway bar. The ends of each sleeper are bent down to give the sleeper a better hold in the ground.

The steel racers, Fig. 2, have straight sloping sides with a flange at the bottom, while the upper surface is bevelled to suit the cone of the trucks for the particular pivot, except in the case of the rear racers for "A" pivot, which are not bevelled on account of those for two adjacent guns in some works crossing each other. The dimensions of the flange are the same as in the wrought-iron racer. The height to the axis of the cone or bevel is 2¼"; the latter is 2·44" long, and the width at the bottom just above the flange 3·48". The flanges of the trucks are allowed $\frac{1}{10}$" play between them and each side of the racer, and ¼" between them and the flange of the racer.

* The racer for the 7" M.L.R. Moncrieff platform, Mark I., is of similar section to that for wood platforms, but wider, and the trucks being flat-soled, it is not laid "raised."

The following are the radii of the racers for the various pivots, namely:—

Nature of Pivot.	Radius. 7" and 9" M.L.R. Front.	7" and 9" M.L.R. Rear.	10" and 11" or 12" M.L.R. Front.	10" and 11" or 12" M.L.R. Cone if Steel.	10" and 11" or 12" M.L.R. Rear.	10" and 11" or 12" M.L.R. Cone if Steel.
	ft. in.	ft. in.	ft. in.	in.	ft. in.	in.
A. - - - -	6 3	16 6	*8 0	·094 for 10" truck; ·194 for 18".	18 0*	Level.
A. first made for Malta and Gibraltar.	—	—	7 9	—	17 9	—
A. Elswick pattern, 9" casemate.	5 5½	16 6	—	—	—	—
C. - - - -	5 5¾	5 5¾	5 8	·379	5 8	·379
D. - - - -	9 0	2 3¾	9 0	·232	3 0	·509
Moncrieff Mark I.,† 7" -	8 3½	5 8	—	—	—	—
Ditto, II., 7" -	9 10	5 7½	—	—	—	—
Ditto, II., 9" -	11 10	6 2	—	—	—	—

* 12" of 35 ton to be 9' 0", in front and cone, ·1291; and 19' 0" in rear, level.
† Moncrieff Mark II. 7" B.L.R. front and rear 6' 10", 64-pr. M.L.R. front 8' 11", rear 4' 8¾".

CHAPTER XI.—FITTING GEAR TO WROUGHT-IRON CARRIAGES AND PLATFORMS.—CARE OF WROUGHT-IRON CARRIAGES AND PLATFORMS.

I. Fitting the Gear.†

Fitting gear. Elevating.

With regard to the capstan head elevating gear, the pinions must be put on so that the jamming levers may tighten when turned to the rear. In the worm wheel gear the worm wheels and their shafts are right and left, and must be so placed. In either elevating gear care must be taken that the proper ends of the arcs are placed uppermost, viz., those marked "top." In removing gear from a carriage the friction rollers are not taken off, as their spindles are not interchangeable.

* For Mark I., 9" cast-iron sweep plates will be used laid in concrete.

† Some of the following points have incidentally been mentioned in describing the gear.



Compressor.

In fitting a carriage with the Elswick compressor, the rocking levers are first placed, and here note that the right-hand lever is that whose jaws are the wider apart. The plates are next placed, the thicker ones on the outside and the lower slots of all to the front. The screw shaft follows, in placing which, when it reaches the adjusting nut, the latter requires to be turned in the same direction as the screw, and to make two revolutions to one of the screw. When the shaft is home the upper ends of the rocking levers should be vertical. The adjusting shaft is then fitted on, after which the levers are secured on the shafts, the adjusting at about an angle of 45° with the vertical, and the compressing vertical. The compressor is next tried for the amount of compression; if the compressing lever goes down too easily, showing that the amount is not sufficient, the adjusting lever is keyed higher up its arc. If, however, sufficient compression cannot be obtained in this way, each lever (the compressing being horizontal and the adjusting vertical) must be removed and placed upon another face of the hexagonal end of its shaft, it will then be found that the required amount of compression can be obtained by keying the adjusting lever somewhere on its arc.

The buffer.

When a buffer is fitted to a platform its cap must bear fairly against the rear transom, and the straight part of the cover be parallel to a straight edge laid across the sides of the platform and at right angles to them. The leather packings being then laid under the bands, the latter are nutted tightly down. To connect the piston rod to the carriage, which must not be quite run up for the purpose, its end should pass centrally through the hole in the bracket, when the connecting nut should be tightly screwed up and then given half a turn back.

Traversing and running-back gear.

In fitting traversing gear to a platform it is convenient to skid up the platform so that the trucks to be geared may be clear of the ground. These, with their bevel wheels attached, are first placed, then the truck shafts with their pinions, next the longitudinal shaft with its clutch, spur wheel, &c., after which the double pinion on its spindle or gudgeon, and finally the cross shaft. As each portion of the gear is correctly fitted in position it should be tightly nutted and keyed before the next portion is placed. The important point in fitting the gear to attend to is that the teeth of gearing wheels do not "ground," *i.e.*, that the tops of the teeth of one wheel do not touch on the hollows between the teeth of the other wheel, but that they have at least $\frac{1}{8}''$ clearance between them.

Note.

Before placing any gear upon a carriage or platform it should be well cleaned and lubricated with Rangoon oil.

II. The Care and Preservation of Carriages and Platforms.

Care and preservation.

All nuts must be kept tightened up; all bearings and parts of gear which work one upon another well lubricated and free from clotted oil and rust.

The carriage rollers should revolve freely upon their axles, and only take a bearing on the platform when the eccentrics are thrown into gear. The eccentrics not being in action, the front rollers have a clearance of ·05″ and the rear of ·1″, which is a very small amount, and consequently should the axles of the front rollers become but slightly bent, the carriage in running up, instead of moving on its rollers, will slide. From this it follows that the straightness of the front axles has to be attended to.

The faces of the buffer blocks upon the carriage and platform should be parallel one to the other, or else the spindles of the buffers are liable to be twisted.

When the rear rollers are brought into play for running up and the pawls of the sockets placed, the latter should bear not on their pins but on their shoulders.

A carriage fitted with the hydraulic buffer must never be fired from unless it has clips, and it is perhaps unnecessary to add, that before such a carriage can be dismounted from its platform the clips must be removed.

The friction roller of the elevating gear is liable to be set fast by corrosion, if so, it may be carefully removed and cleaned.

When carriages are mounted in exposed situations and not required for constant use, the elevating and compressing gear is better removed from them and placed in the store adjacent, but if so, it should be periodically fitted to the carriages and tested as to its completeness and good working order.

In the same manner the buffer may be removed and placed in store, the oil being first run out, though, if it is required for occasional use, it may be left filled and periodically examined.

If a buffer leaks at the gland and the leakage cannot be stopped by tightening the latter, the packing must be renewed.

If the cover has at any time to be removed, in replacing it red or white lead may be used to make a close joint in place of Scott's mineral composition. In taking a buffer to pieces the cap and flange are never removed, nor the emptying cock from the latter.

The block of the running-back gear on the carriage should be kept in store unless when in use, also that on the platform, if it is movable.

Traversing gear should be worked at least once a week, to test its state, and also to change the position of the platform on the racers.

During practice, the surfaces of the platform upon which the carriage slides should occasionally be slightly oiled to prevent seizure between the carriage and platform, and to ensure uniformity in the action of the buffer. This is especially necessary in dry frosty weather and with the heavier guns.

Compressor plates and bars are on no account to be oiled. A little superficial rust on them is not detrimental, but much rust is inconvenient, as for the same amount of compression by the levers, it varies the amount of recoil, in fact, the recoil may be one round very little and the next very great. If bars become so rusted they should be scraped.

If the paint becomes rubbed off any part of a carriage, it should be patched over as soon as possible to prevent rust.

In repainting carriages and platforms care must be taken not to paint any bearings or gearing parts, for instance, soles of trucks, teeth of pinions and wheels, the upper surfaces of the platform on which the carriage slides, the sliding surfaces of the carriage, &c.

Packing for transport.

Except the capsquares, friction roller, and centre bearing for the eccentric shaft, all the fittings, together with the metal rollers, are removed and packed in a case.* The same case may also take the fittings of the platform, including traversing gear. The kind of gear packed, the nature of gun for which the carriage and platform is intended, and the register number of each of the latter, is painted upon the case.

Wood blocks are placed between the plates of the carriage in the position of the rollers, those in front secured by the roller spindles, those in rear by wood pins. Similar blocks are placed in the flanged feet of the platform and retained by the truck spindles.

The trucks, if fitted for gear, are packed in a case, if not so fitted, they remain loose.

The buffer is left in its position on the platform, a wood block being secured over the piston rod to keep the piston run back and to protect the end of the rod.

*** Each item of the gear, if not already marked with the register number of its carriage or platform, as the case may be, must be so marked.**



The long shaft of the traversing gear is lashed beneath the platform; short shafts are packed in the case. Foot planks remain in position; side steps are lashed on.

If the platform is fitted with compressor bars they remain in position and are secured by wooden blocks over them, fitting between the sides of the platform, and so formed as to jam them altogether.

CHAPTER XII.—TRANSPORTING CARRIAGES.

Transporting Arrangement for Sliding Carriages and Traversing Platforms.

For wood carriages and platforms. (R.C.D. photo-lithograph, 60.)

For transporting wood sliding carriages short distances on good roads an axletree is passed through a hole for the purpose in the front block; upon this two wheels are placed, and then the rear of the carriage is limbered up to a dilly, the pintail of which passes through an eye plate in the rear block.

The axletree is a 3″ bar of round iron $5\frac{3}{4}'$ long, weighing 1 cwt. 0 qr. 11 lbs., and fitted with plain washers and keys, with rope ties, as linch-pins.

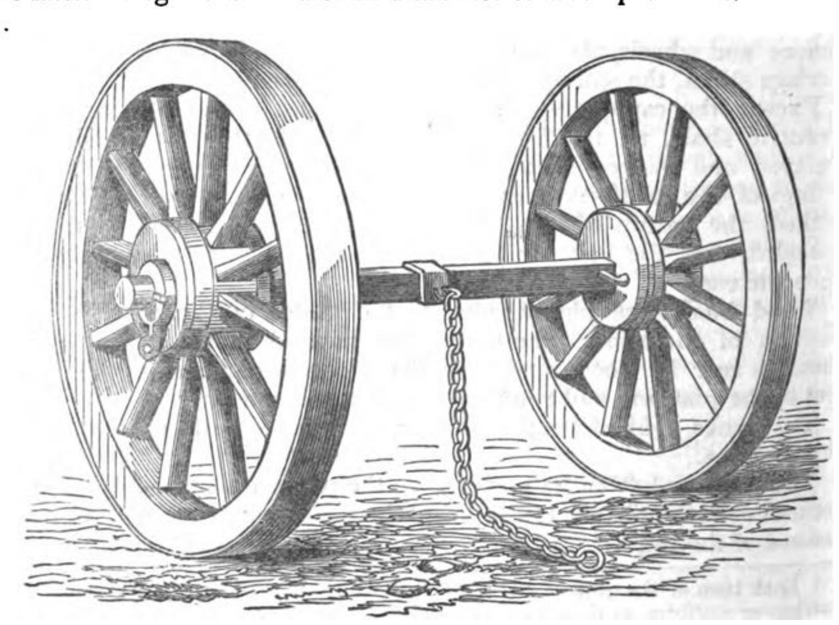
The wheels are O.P. 4′ 2″ in diameter, special class, with cylindrical pipe boxes, and the spokes set in the nave without any dish; they are shod with 3″ ring tire, and weigh each 1 cwt. 1 qr. 21 lbs.

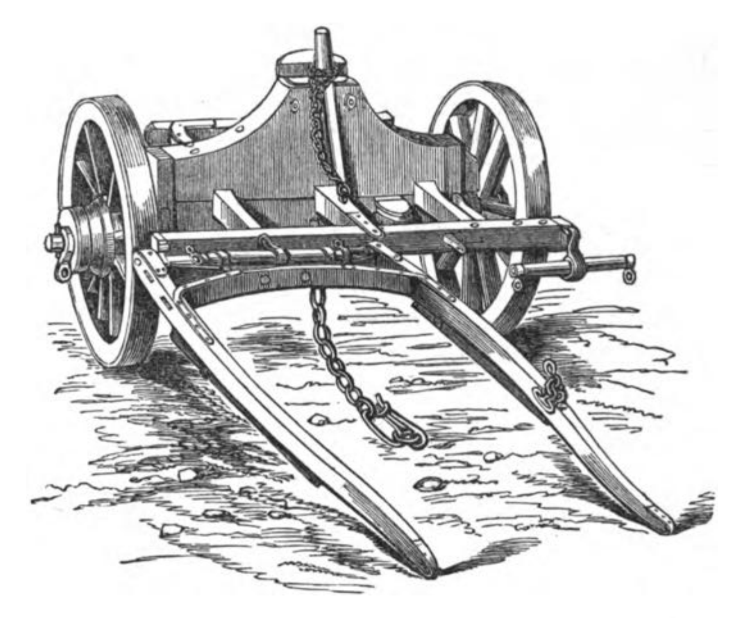
The dilly consists of an iron axletree, an axletree bed, and block of elm, with a perch and its two stays of ash, housed between them. It is fitted with a pintail (with key) over the bolster, and mounted upon O.P. special wheels (with dish) 2′ 4″ in diameter, weighing each 2 qrs. 1 lb., and shod with 3″ ring tire. The perch is fitted with a cross handle for man draught, and a ring for a drag rope.

The same arrangement serves to transport a platform, the axletree passing through bands for the purpose, and the pintail of the dilly entering the bent plate between the sides in rear.

For iron carriages and platforms. (R.C.D. photo-lithograph, 61A.)

Wrought-iron sliding carriages are not fitted for a transporting arrangement, but are transported when necessary upon their platforms, the latter being moved in a similar manner to wood platforms.





There are four transporting axles for iron platforms, of the same section in the body, viz., 4″ square,* with cylindrical arms, but differing in length, as follows :—

Nature.	Total Length.	Weight.
	ft. in.	cwts. qrs. lbs.
7″ double plate or 7″ and 9″ single plate -	7 3	3 1 4
9″ double plate - - - -	7 9½	3 1 6
10″ ,, - - - -	8 8	3 3 5
11″ or 12″ double plate - - -	9 11	4 0 8

Each axle is fitted with a pair of drag washers and keys, with rope ties, as linch-pins, and a draught chain is attached to the centre of it by a socket band.

The wheels are O.P. special class, 5′ in diameter, having cylindrical pipe boxes, and the spokes set without dish. Each is shod with a 6″ ring tire, and weighs 4 cwt. 1 qr. 14 lbs.

The limber consists of an iron axletree, an axletree bed and bolster of elm, with three futchells of ash housed between them. The outer futchells project to the rear, and have a sweep bar attached to them, and all are mortised into a splinter bar of ash in the front. A sweep plate and pintail is fitted upon the bolster, and a keep chain with hook to the centre futchell. The splinter bar has a pair of frame shafts for single or double draught, a swingletree being also supplied for the latter. The wheels are O.P. second class, 3′ in diameter, shod with 4″ ring tire, weighing each 1 cwt. 2 qrs. 14 lbs., and have a track of 4′ 7″. A draught chain with a tongue and slip ring is attached to a bar on the rear of the dilly for connexion with the chain of the axle.

The 7″ and 9″ axles are sufficiently strong to take the gun without its carriage on the platform, but this method of transporting the gun should only be resorted to on emergency.

* The first made platforms took the round axle as for wood platforms.

Platform Wagon.

Platform wagon.

The platform wagon is the same as described for siege service, but without fittings for spare stores, and without bale hoops and canvass cover. It will carry any load to five tons.

Drugs.

Drugs. (R.C.D. photo-lithograph, 74 and 74A.)

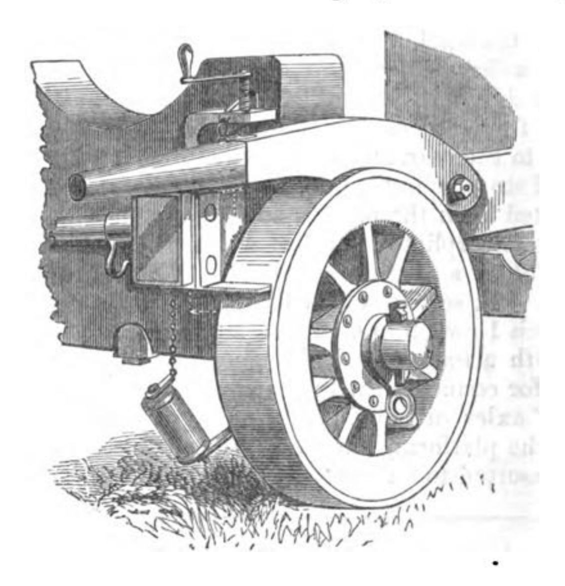
Drugs are of several sizes, namely,—

Nature.	Weight.			Ton-nage.	Diameter of Trucks.		Track of Trucks.	
					Fore.	Hind.		
	cwts.	qrs.	lbs.	tons.	ins.	ins.	ft.	in.
Small or West India drug -	5	0	0	·58	18	18	3	2
Medium - - -	10	2	0	2·02	20	20	3	9½
Large - - - -	17	2	0	2·17	24	24	3	8
Gun drug to 5 tons - -	16	1	0	1·81	24	24	3	8
„ to 25 tons - -	61	1	0	7·25	24	36	5	8

The lighter drugs are constructed of English oak, the 25 ton drug of African oak; each consists of a platform over a fore and hind carriage. The fore carriage locks under, and its trucks as well as those of the hind carriage, except in the 25 ton gun drug, are of cast iron. In the 25 ton gun drug the hind trucks are really N.P. wheels of the special class made with cylindrical pipes, and the spokes without dish; they have the nave in two parts only, the inner flange and pipe being in one, and are shod with an 8″ ring tire; the front trucks are of wood, plated, metal bouched, and shod with 8″ ring tire.

The platform in a gun drug is formed by two longitudinal pieces connected together, but in another drug by four; in the large drug and in the 5 ton gun drug the platform is fitted with iron standards, and in the 25 ton gun drug with two movable wooden bolsters, the rear bolster, which the second coil of the gun rests upon, varying in depth according to the nature of gun.

The small and medium drugs are fitted for man draught; the large drug with frame shafts for double draught; the 5 ton drug with frame



shafts for single draught, and the 25 ton drug with two pairs of frame shafts, and outriggers for four horses abreast.* The latter drug has drag washers with loops sufficiently large to take the hook of a parbuckle rope, and also loops on the front bolster; over each of the hind trucks is a wooden brake, worked by a screw, (see Fig.), and, attached by a chain to the axletree, is a roller to scotch the truck.

SLEIGHS.

Sleighs.

Sleighs are used in conjunction with rollers for moving guns of 18 or 25 tons.

A sleigh is made of African oak, and consists of two side pieces connected by three wood transoms, and secured together, by five bolts with keys, at 30″ apart; the ends of the sides are bound with iron hoops and their lower edges are shod with angle iron. The sleigh is fitted with two bolsters for the muzzle and cascable of the gun to rest on.

Three rollers of African oak, hooped with iron and pierced with holes to receive the ends of iron-pointed levers, are issued with each sleigh; the rollers are 8′ long and 12″ in diameter.

It is usually necessary to place 3″ planks for the rollers to run upon.

The weight of a sleigh is 59 cwt. 1½ qrs., and its tonnage 4·35 tons.

SLING WAGONS AND CARTS.

Sling wagons and carts.

The sling wagons and the sling cart in the service are,—

Nature.	Weight.			Tonnage.	Wheels.						Track of Wheels.	
					Body.			Limber.				
					Class.	Diameter.	Width of Tire.	Class.	Diameter.	Width of Tire.		
	cwts.	qrs.	lbs.	tons.		ft.	in.		ft.	in.	ft.	in.
Sling wagon, wood, Mark II., to 6 tons.	36	1	0	8·27	O.P. I.	7	6	O.P. II.	5	3	6	6
Sling wagon, iron, Mark I., to 7 tons.	42	2	0	5·556	N.P. I.	7	6	N.P. II.	5	3	5	11
Sling cart, wood, Mark II., to 3½ tons.	18	0	0	3·95	O.P. I.	5½	6	—	—	—	5	9

Besides the above a few sling wagons have been constructed to take 12 ton guns and also others for 23 ton guns, but no more will be manufactured, and those in store will be retained for use in arsenals.

Wood sling wagon, Mark II. to 6 tons. Construction of body.

The wood sling wagon is of oak, and consists of a body and limber.

The frame of the body is formed of a perch, two sides, two cross bars, two brackets, and an axletree bed. The perch and sides are housed and bolted across the axletree bed, the sides projecting slightly to the rear beyond the bed. The perch is of greater depth at the middle than at the ends, and plated upon its under surface, and has a nose plate with steeled eye, for attachment to the limber, upon its extremity. The front cross bar is secured by a yoke band over the perch, and bolted to the front ends of the sides, the rear under the perch and sides a little in front of the axletree bed. The brackets, which are short and low, are bolted one upon each side immediately over the axletree bed for the support of a windlass. The lower edges and upper surface of the bed are protected by plates, and the axletree is

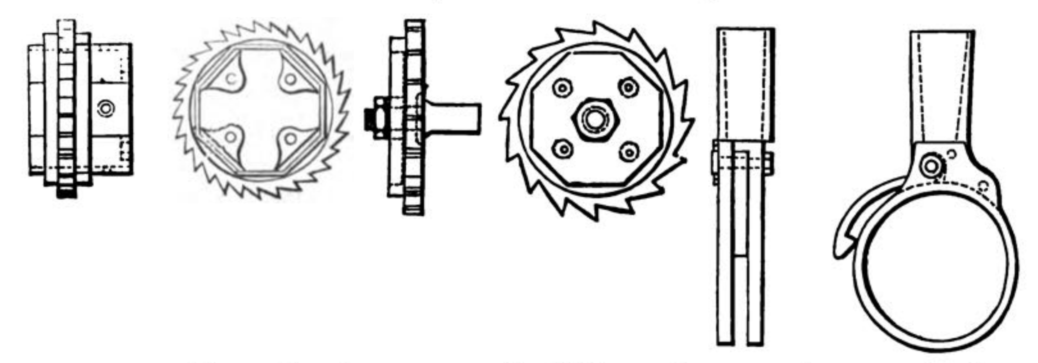
* The shafts of gun drugs are adapted for farmer's draught.

secured in it by a bolt, by yoke bands, and by clips. As already seen, the wheels are first class O.P.; formerly they were shod with streak tires, but now are shod with ring tires. Each weighs 6 cwt. 2·43 qrs.

Windlass.

The windlass is of elm, cylindrical in the centre with octagonal ends, hooped with iron and pierced with mortise holes to receive wooden pawls. On each end of the windlass is a ratchet arrangement, consisting of a barrel with ratchet ring, two socket rings with socket and pawl, and a ratchet plate with gudgeon.

The barrel, see Fig., is octagonal, of wrought iron (Mark II. windlass), made in two parts, and having four lugs upon the inside; its ratchet ring is shrunk upon and riveted to it, the barrel itself fits over the end of the windlass, and is secured to it by screws.



The socket rings, on one of which a socket to receive a wooden lever is formed, fit over the barrel, one on each side of the ratchet ring. They are secured together by screws, and are free to move round the barrel, except when the pawl, which is pivoted between them by a pin with washer and keep pin, is caught in the teeth of the ratchet ring, in which case the barrel, and therefore the windlass as a whole, must turn with them. By this arrangement of the socket rings the windlass can be worked continuously.

The ratchet plate has teeth upon its circumference, while through its centre the gudgeon or axle of the windlass passes and is nutted upon the inside. The plate lies upon the end of the windlass, and has upon the inside eight projecting edges, over which an octagon ring is riveted. The ring projects over the end of the barrel, and the plate is secured to the lugs of the latter by screws. The gudgeon projecting from the plate enters a metal gudgeon plate on the bracket of the wagon, where it is secured by a capsquare and key. On each bracket there is pivoted an iron pawl to work in the teeth of the ratchet plate and prevent the windlass turning back.

Upon the centre of the cylindrical part of the windlass there is a hook to take an eye formed in the centre of the gun sling, and upon the axletree bed in front and rear at each side a similar hook or pin to take an eye splice in each end of the sling. When the sling is so placed and the windlass worked from the rear of the wagon, the gun or other article slung is raised from the ground.

In Mark I. windlass, the ratchet arrangement, except the pawls, were of cast instead of wrought iron, the ratchet ring $\frac{1}{2}''$ narrower, and the gudgeon $\frac{1}{2}''$ shorter; such a windlass may readily be recognised by the shape of the teeth, which are curved on the upper side instead of straight. A wagon fitted with Mark I. windlass is only capable of transporting a weight up to $4\frac{3}{4}$ tons.

Fittings of body.

The fittings on the body are two trail handles and a locking plate on each side of the perch; a ring for the attachment of a draught chain

from the limber underneath the perch ; another ring for a drag rope, when required, upon the point above. Upon the inside of each side there is a bearing plate for a movable cleat. There are also fittings on the perch for a drag shoe and chain.

Limber. The frame of the limber consists of an axletree bed, a bolster, three futchells, and a splinter bar, connected in the usual manner. A straight pintail with bearing plate is fitted upon the bolster to receive the trail eye of the body, and a keep chain with hook is attached to the centre futchell. The wheels are the heavy field. The splinter bar is fitted with a pair of field shafts and with a pair of frame shafts, also with outriggers and swingletrees for four horses abreast. The siege shafts can be placed for either single or double draught. A draught chain with tongue and slip ring is attached to a staple upon the rear of the axletree bed.

Articles belonging to. The following articles, in addition to the windlass, belong to the wagon, namely :—

Sling of 5″ white rope, 9′ long from centre to end.

Two sets (of two each) of iron thimbles, respectively 12″ and 9″ in diameter, to fit over the trunnions of gun and take the sling.

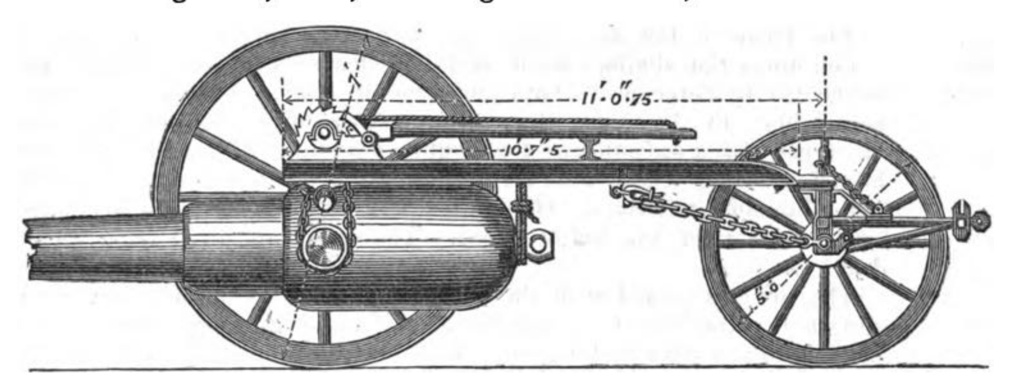
One lashing rope of $2\frac{1}{2}$″ tarred rope, 33′ long, to lash the breech of the gun up to the perch.

Four levers of ash, two with a fall each of 2″ tarred rope 15′ long. The levers are each 6′ $8\frac{1}{2}$″ long, oval in section, with square end to enter sockets, and in Mark II., with the part which enters the socket gradually sloped off instead of cut with a shoulder, as in Mark I.

Two pawls of ash to secure the windlass, when travelling with a weight on it.

A wooden cleat with iron pins to enter the bearing plates on the sides of the wagon. This cleat, when a carriage is carried, enters the trunnion holes and steadies the carriage.

Five swingletrees, No. 1, and a drag-shoe and chain, first class.



Iron sling wagon, Mark I., to 7 tons. Construction. The iron sling wagon (see Fig.) is of the same general form as the wood wagon in the body and limber.

The perch and sides of the body are of girder iron, and are connected by a cross piece, also of girder iron, riveted over them in front, and by the axle riveted to them in rear, a stay of round iron being added from the perch to each side. The axle is in one piece, arched in the body and has projecting from it in the centre two lugs, which lie along the web of the perch, and through which the rivets connecting it to the latter pass ; also, at each shoulder a projecting piece which lies under, and by which it is riveted to the side. The brackets are of tee iron, and are riveted to the sides, so as to support the windlass immediately over the shoulders of the axletree. The perch is fitted with a nose plate with

eye, the plate having lugs projecting from it which lie along the web of the perch, and through which the rivets pass. The wheels are shod with ring tires, and weigh each 6 cwt. 3·785 qr.; the outer flange of the nave is flush with the end of the pipe box, and both flanges are of wrought iron.

The windlass is similar to that of the wood wagon, but longer, and protected against the sling by iron plates; metal bearings with cap-squares are riveted in the brackets to receive its gudgeons, and iron sockets to take the spindles of the pawls.

Fittings. On each end of the body of the axletree there are, in rear, two hooks or studs to take the end of the sling; each stud has a clip formed upon it, which fits on the axle and is secured by a screw. At the position of the lashing rope the sides of the perch, between the tees, are filled in with wood. The remaining fittings of the body are the same as in the wood wagon, except that there are no bearing plates for a movable wood cleat.

Limber. The limber is wholly of iron; its axletree bed is built up by riveting a plate of the proper form to each side of the body of the axle; the pintail passes down between these plates and screws into the axle, and a bar corresponding in form to the upper edges of the plates is riveted between the latter, from the pintail on each side to the shoulder of the axle, thus completing the bed. The futchells, three in number, of tee iron, are riveted to the axletree bed and bolted to the splinter bar. The latter is of plate, trough-shaped, and strengthened by a stay of round iron at each end to the bed. A bearing plate is riveted upon top of the bed, and a stay led from the same part to the centre futchell.

The fittings for draught, the keep and draught chains, are as in the wood wagon.

The articles belonging to the wagon are the same as those of the wood wagon, except that the sling is of ⅝″ chain and 9′ long, and the movable wood cleat is dispensed with.

Sling cart, wood, Mark II., to 3½ tons. The frame of the sling cart consists of two long sides, the ends of which form the shafts, housed and bolted across an axletree bed, and connected by three cross bars and two tie bolts. The splinter bar is bolted beneath the sides; the end projecting on the near side forms an outrigger for a swingletree for double draught. Upon the sides are bolted brackets in the same manner as in the wood sling wagon, and to take the same windlass. Hooks for the ends of the sling are fixed upon the rear of the axletree bed. The shafts are fitted for farmer's draught.

The articles issued with the cart, in addition to the windlass, are a sling and thimbles, levers, and pawls, as for the sling wagon (wood); a prypole of ash with lashing rope of 2½″ tarred rope 18′ to 30′ long, and one swingletree, No. 1. The prypole is bent and is placed, from the rear over the axletree bed and under the rear cross bar, so that the breech of a gun when slung can be lashed up to it.

Mark I. cart could only transport 56 cwt., as the windlass had cast-iron fittings.

Trench Cart.

Trench cart. The trench cart has already been described in the siege equipment; it has second class O.P. wheels 4′ 2″ in diameter, and having a track of 4′ 3½″. It will take a load of one ton, and is painted red to distinguish it from the hand cart. Two slats are issued with it for man draught. The weight of this cart is 7 cwt., and its tonnage 1·57 ton.



Hand Cart.

Hand cart.

The hand cart is similar to the trench cart, but of lighter construction and with third class O.P. 4′ 2″ wheels, having a track of 4′ $5\frac{1}{2}$″. It will take a load of 15 cwt., its weight is $4\frac{3}{4}$″ cwt., and its tonnage 1·25 tons. Two slats are issued with it for man draught.

This cart is frequently fitted with a pole with cross handle for man draught, instead of shafts.

Low Cart for Heavy Projectiles.

Cart for heavy projectiles.

The frame of this cart is of angle iron with two summers of tee iron; it is boarded over and has low sides and front of plate riveted to it. The axle is third class and is secured beneath the sides by clips bolted to the latter. The wheels are O.P. 4′ 2″ in diameter, with 5″ ring tire, they weigh each 1 cwt. 2 qrs. 22 lbs., and have a track of 4′ $5\frac{1}{2}$″.

The cart is fitted with a pole, with cross handle, for man draught; beneath the pole is an iron prop, and under the rear of the cart two more similar props.

Across the bottom of the cart are wooden battens to steady the projectiles carried; a loading plank (weight $2\frac{1}{2}$ qrs.) is issued with the cart.

Barrows.

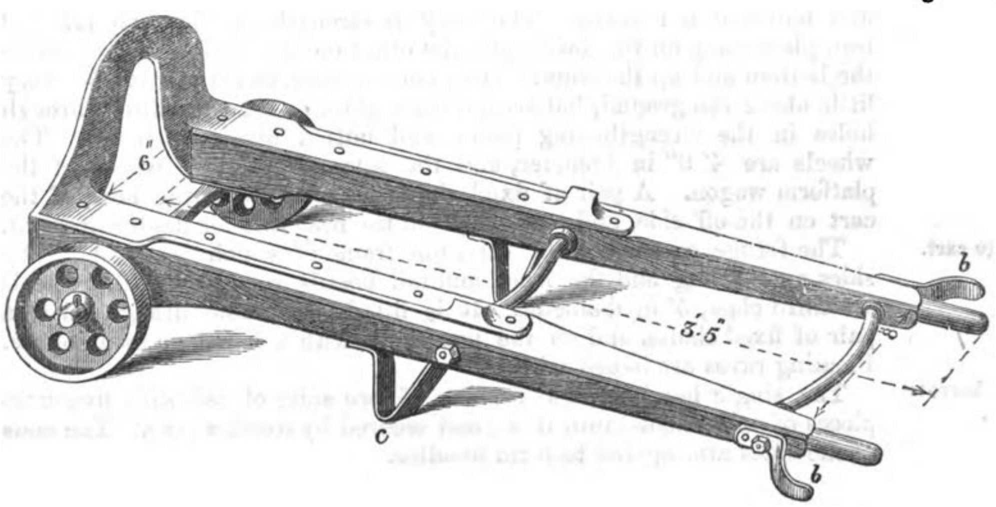
Barrows.

Nature.	Weight.	Tonnage.	Height of Wheel.	Track of Wheels.
	lbs.	tons.	ins.	ins.
* Truck barrow, for transporting heavy projectiles (7″ B.L. to 12″ M.L.) in magazines, Mark I.	62	·125	7	$14\frac{1}{4}$
Barrow, magazine, single, for transporting powder in magazines, Mark II.	69	·172	$9\frac{1}{2}$	22
Ditto, double, Mark I. - - -	160	—	17	20
Powder barrow, covered, for transporting ammunition in batteries, two wheels.	115	·182	30	22
Ditto, one wheel - - -	117	·182	$20\frac{1}{2}$	—
Charge barrow, for transporting powder in laboratories.	88	·	18	—

* A new barrow is now being designed for the projectiles of the 12″ of 35 tons.

Truck barrow for heavy projectiles in magazines.

The truck barrow, see Fig., for transporting heavy projectiles in magazines, consists of two oak sides connected by two bent tie bolts, and by a



head plate which is extended along each side, and upon which the projectile lies. An iron axle is bolted beneath the sides, and is fitted with metal trucks. Iron knuckle guards are fixed on the handles, and iron feet beneath the sides.

Single magazine barrow for powder. The single magazine barrow for powder is similar to the magazine barrow for projectiles, but with metal knuckle guards, one wood and two metal cross bars, one of the latter forming the axle. Mark I. was not fitted with knuckle guards.

Double powder barrow The double powder barrow is formed of an upper and under frame; the latter is connected to the former, and sloping away from it to the rear forms the legs of the barrow. The trucks are metal and held in metal bearings in the lower frame and underneath the upper. The latter frame is plated with metal.

Covered powder barrow with two wheels. The frame of this barrow is of oak, with head semicircular pieces of elm; the boarding is of deal, the top arched and covered with canvass and the end closed by folding doors. The interior nails and fittings are of copper. The barrow has an iron axle, O.P. wheels, special class, and drag washers; the rear is supported by two wooden legs.

Covered powder barrow with one wheel. This barrow is similar to the foregoing, but fitted like an ordinary wheel barrow with a single wooden wheel.

Charge barrow. The charge barrow is a long open barrow with upright head, to which a canvass cover is nailed. The tire and axle of its wheel are of metal; in rear it is supported on two wood legs.

Portable Magazines.

Magazine, portable, with bearers. The portable magazine, with bearers, is a kind of large box with ridge shaped lid opening on hinges. It is fitted with staples on the sides to take the bearers, and with cleats to stand upon.

Magazine, portable, with trucks. The portable magazine, with trucks, is larger than the preceding: it is of similar construction but the ridge roof runs across instead of lengthways; it is mounted on four small elm trucks, and has an iron handle for lifting at each end.

Miscellaneous Carts and Barrows.

Miscellaneous carts and barrows.

Coal cart. The coal cart is a tip cart, the frame of which is of oak and the boarding of deal: floating rave boards are fitted on the sides and head. The cart takes the O.P. field wheel, and is fitted with an outrigger for double draught; it will carry a load of one ton.

Fatigue cart. The fatigue cart is the preceding without rave boards.

Duck cart. The duck cart is made entirely of oak; it has fixed sides and head, and movable tail board. The body is strengthened by two cranked iron plates, one on the inside and the other on the outside, bolted across the bottom and up the sides. It has no axletree, as the bottom lies very little above the ground, but second class axletree arms are fitted through holes in the strengthening plates, and nutted upon the inside. The wheels are 4′ 0″ in diameter, and the same as the fore wheels of the platform wagon. A pair of fixed shafts are attached to the head of the cart on the off side, and trace loops on the near side for double draught.

Forage cart. The forage cart is a light cart, the frame of which is of ash. The sides are folding and the head and tail boards removable. Its wheels are third class, 5′ in diameter. It is fitted for double draught with a pair of fixed shafts, and on the near side with a bar for a swingletree. Floating raves are issued with it.

Hand barrow, single. The single hand barrow consists of two sides of ash with five cross pieces of oak tenoned into them, and secured by wooden pins. The ends of the sides are tapered to form handles.

The double hand barrow is larger than the single, and has two cross pieces bolted beneath the frame, which form two additional handles at each side. **Hand barrow, double.**

The sack barrow is formed of two sides connected by four cross pieces, and fitted with a high iron head for the load to rest against. It runs on two cast-iron trucks placed beneath the frame in front, and has two short wooden legs in rear. **Sack barrow.**

The wooden coal barrow is an ordinary wheel barrow, with single wood wheel, high sides, head board fixed, and sliding tail board. **Coal barrow, wood.**

The iron coal barrow is a skeleton iron barrow with single iron wheel, and a coal box of sheet iron fitted into the frame. **Coal barrow, iron.**

The turf barrow is simply a hand barrow fitted with a wood crate, the uprights of which are prolonged beneath the frame of the barrow to form legs. **Turf barrow.**

CHAPTER XIII.—MACHINES.

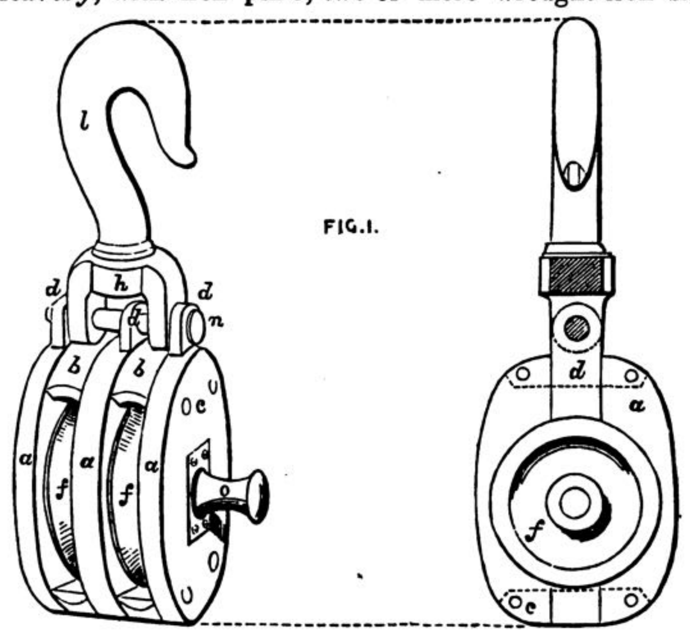
TACKLES.

A tackle consists of one or more blocks with a fall of rope. **Tackles.**

Blocks are of two descriptions, namely, Admiralty and Bothway's; and of each description there are single, double, and treble blocks, according to the number of sheaves. **Blocks, Admiralty.**

An Admiralty "rope strapped" block consists of a shell of elm, a sheaf or sheaves of wood or metal with iron pin, a rope strap, an iron hook with thimble, and an iron thimble or rope loop. The pin passes through the centre of the shell and sheaves, furnishing a support for the latter to revolve upon in the former. The rope strap is spliced round the shell, attaching the hook to the latter at one end, and the thimble or loop at the other.

A Bothway block consists of a shell *a*, *Fig.* 1, of elm, one or more metal sheaves *f*, with iron pin *o*, two or more wrought-iron straps *d*, **Blocks, Bothway's.**



according to the number of sheaves, and a shackle *h*, with swivel hook *l*, and pin *n*; in addition to these parts, in the smaller natures there is a

small shackle with thimble and pin for the attachment of the standing end of the fall; in the larger natures the latter is made fast to a button *o*, formed on the head of the pin supporting the sheaves.

The shell is in parts held together by four rivets *c*, and the straps pass down through it on either side of each sheaf. The pin supporting the sheaves passes through the straps so that they and not the shell, as in the rope-strapped blocks, support the weight or strain. The ends of the straps project beyond the top of the block for the attachment of the shackle with its hook, a pin secured by a key forming the connexion. The hook can revolve in the shackle; the former in the latest pattern blocks is stronger than in the first pattern, being of greater width and depth of section at the bearing part. If the block is fitted with a thimble the straps project beyond the lower end, and have the small shackle with its thimble attached to them in the same manner as the larger at their other extremities. The metal sheaves are now made of harder alloy than formerly (the same as used for pipe boxes of wheels), and to distinguish them are stamped with the letter "H" on the boss; the pin used with such sheaves is case-hardened and also stamped with the letter "H."

Blocks, whether Admiralty or Bothway's, single, double, or treble, are distinguished by the length of the shell in inches, which is stamped upon it, thus, Admiralty blocks are "single" 3″, 4″...to 9″, "double" 3″, 4″...9″, "treble" 6″, 7″, 8″, 9″; and Bothway's are 7″, 10″, 12″, 15″,* and 18″,* either single, double, or treble.

Snatch blocks. A snatch block, Fig. 2, is an "iron-bound" Admiralty single block,

Fig. 2.



the iron strap being made at one side to open with a hinge, so that a rope can be placed in it on the sheaf without the necessity of reeving it from its end. Snatch blocks are 8″, 10″, 12″, 15″, and 18″.

The sized rope which a block will take may be ascertained by dividing the length of the block or its size by 3.

---

* Mark III. of 15″, and Mark II. of 18″, are latest and strongest patterns; of other natures there is only one Mark.

The principal natures of tackles are as follows :—

Natures of tackles.

A "whip;" one single Admiralty block with fall.

A "luff tackle;" one single and one double 8″ Admiralty block with 10-fathom fall of 2½″ tarred rope.

A "gun tackle;" two double 8″ Admiralty blocks, with 12½-fathom fall of 2½″ white rope (for use with 7″ B.L.R. and 68-pr. S.B.), or one double and one treble 9″ Admiralty block with 16 fathoms of 3″ white rope (for use with M.L.R. heavy guns).

A "gyn tackle;" two treble 12″ Bothway's blocks, with 18-fathom fall of 4″ white rope (for light gyns), or, two treble 15″ Bothway's blocks with 18-fathom fall of 5″ rope (for heavy gyns).

A "sheers tackle;" two treble 18″ Bothway's blocks with 113-fathom fall of 6″ white rope.

The Crab Capstan.

The crab capstan.

The crab capstan consists of a framework and windlass with two capstan bars.

The frame is formed of two straight and two curved pieces of oak scantling bolted to a block of African oak at one end, and at the other to transoms; the two straight pieces to one transom, and the two curved to another. The straight pieces with their transom and the under side of the block form the base of the capstan. The transoms are connected by vertical bolts, in the lower there is a gudgeon socket, and in the upper a recess with capsquare to secure the windlass. The latter is of elm, and stands upright in the frame, the lower part, round which the rope is passed, is conical, the upper part cylindrical, with holes through which the capstan bars, which are of ash or rock elm, 16′ long, are passed.

Winches.

Iron winches.

Iron winches or crabs consist of an oak frame which lies on the ground, and upon each side of which a cast-iron skeleton bracket is bolted. Between the brackets an iron windlass with gear to drive it is fitted, and the brackets are connected by tie bolts.

These winches are "single" or "double" purchase; in the single purchase the windlass is driven by one wheel and pinion, in the double by a train of two wheels and pinions, in order to gain greater power. In both winches the driving pinion is moved by means of winch handles, the brackets and frame are the same. The strength of each equals 2 tons on the barrel.

Triangle Gyns.

Triangle gyns.

Triangle gyns were formerly constructed of wood, but now are made of wrought iron; they are as follows, for garrison service, viz.:—

Nature.	Weight.			Tonnage.	Diameter of Spar.	Diameter of Bolt.
	cwts.	qrs.	lbs.	tons.	in.	in.
18′ light, wood, Mark II., to 7 tons*	14	1	7	1·57	7	1½
18′ heavy, wood, Mark II., to 12 tons*	26	2	19	2·07	9	2
18′ light, wrought iron, Mark I., to 7 tons.*	14	2	18	1·275	4½	1½
18′ heavy, wrought iron, Mark I., to 12 tons.*	27	2	13	2·075	6½	2

* When the feet form an equilateral triangle.

Light wood gyn.

A triangle gyn consists of two cheeks with cross bars, a prypole, a windlass, and a shackle with bolt and key.

The prypole and cheeks of a wooden gyn are of Riga fir spars, the tops shod with iron cap plates, and the lower ends hooped and fitted each with a collar spike. The shackle bolt connects the upper ends of the cheeks and prypole passing through the caps (and shackle as well) from the right and being keyed on the left. The lower ends of the cheeks are connected by two iron cross bars, the windlass being first placed in position, *i.e.*, with its gudgeons in cast-iron sockets in cleats of African oak, which are secured one on the inside of each cheek by hoops and rivets.

The shackle and its bolt are of wrought iron; the upper block of the tackle is hooked to the former, point to the prypole.

The windlass is on the same plan as that of the sling wagon or cart, the ironwork being identical in the light gyn with that of the latter windlass. In Mark I. light gyn, as in the wagon and cart, the fittings were cast iron, and therefore this gyn can only take a weight up to 6 tons. The pawls for the windlass are attached to the insides of the cheeks on collar spindles.

The articles belonging to the gyn are as follows :—

One gyn tackle of two treble 12″ blocks, and 4″ fall.
Four levers, two with ropes, the same as for the sling wagon.
Three wood trucks for the feet to rest in, if required.
Two slings of 6″ white rope, one 10′, the other 11′ long.

Heavy wood gyn. (R.C.D. photolithograph, 72A.)

The construction of the heavy wood gyn is the same as that of the light, but two link loops are added, one in each cheek, to take a handspike for a man to mount upon to reach the upper block of the tackle, and the prypole is fitted with an eye to take the hook of the block of an erecting tackle. The windlass is the same as that of the light gyn, except that the sockets are larger.

The articles belonging to the heavy gyn are,—

A gyn tackle of two 15″ treble blocks with 5″ fall.
An erecting tackle of one single 8″ Admiralty block with 7-fathom fall of $2\frac{1}{2}$″ white rope, by which to raise the main tackle for placing it after the gyn is in position.
Three wood trucks, as for light gyn.
Four levers, two with three ropes each, larger in section than those for the light gyn.
Three slings of 9″ white rope, viz., one long sling 16′, one breech sling of 7′, and one muzzle sling of 3′; the two latter each fitted with a thimble, and also with a grummet of 3″ tarred rope, which closes the sides of the sling upon the gun.
One lashing rope of 3″ bolt rope, 10 yds. long.

Light and heavy iron gyns. (R.C.D. photolithograph, 72B.)

The light and heavy iron gyns consist of the same parts as the wood gyns; the cheeks and prypole are of wrought iron tubing with a cap shrunk on each end, the lower cap being fitted with a stud. The sockets for the gudgeons of the windlass and for the pawl spindles are made with iron bands, which pass round the cheeks and are secured by bolts.

The heavy iron gyn has no link loops for a handspike, but has a third connecting bar instead.

The articles belonging to each gyn are the same as the corresponding wood gyn, except that the heavy gyn has in addition an 8′ lever for the prypole.

Colonel Hay, R.A., has proposed an alteration in the service gyn, namely, to fit the prypole with an arched and forked end, so that the shackle might be done away with and the upper block of the tackle hooked to the bolt between the forks of the pole. This arrangement has the advantage of allowing the gun to be raised to greater height than in the service gyn. In an experimental heavy gyn so fitted the diameter of the bolt has been increased to 2¼″, which is sufficiently strong to allow of the prypole being placed 14½′ from the cheeks. **Note.**

A gyn fitted with Col. Hay's prypole has the cross bars of different lengths to those of the service gyns.

Sheers.

Spars for sheers are of the best Baltic fir; their dimensions for use with a 12 ton gun are 40′ or 45′ in length, being respectively 16″ or 17″ in diameter at the centre, and for use with a 25 ton gun 45′ long and 20″ in diameter at the centre. One spar is fitted with cleats of elm 2′ apart. **Sheers.**

The tackle used with a sheers for 12 ton gun is as follows :—

*35 fathoms 4″ white rope to lash head.
15 feet strap of 9″ white rope with thimbles for each guy.
Two single and one double 18″ Bothway block, with 113 fathoms of 6″ white rope for each guy.†
One treble and one double 12″ Bothway blocks, with 113 fathoms 4″ white rope for runner for each guy.
Sling, 19′ of 12″ white rope, with thimbles for head of sheers.
Main tackle of two treble 18″ Bothways blocks, with 113 fathoms of 6″ white rope.
Two 18″ snatch blocks, as leading blocks.
Four foot ropes of 6″ white rope, 25 fathoms each.
Selvagees, eight.
Four gaskets of 9″ white rope, of 3 fathoms each.
16 lashing ropes of 4″ tarred rope, each 10 fathoms.
5 " 2½″ " 5 "
Two 12′ slings of 6″ white rope - } for capstans of guys.
Two 4′ " 4″ " - } for capstans of guys.
One chain, 1″ short link, 8 fathoms, for sling.
Two chains, 1½″ short link, 8 fathoms long, for holdfasts.
Spun yarn, 5 lbs.

Steps or shoes of elm with grummet handles are issued for the feet of the spars to rest in. A crab capstan is used to work each guy, and a double-purchase iron crab for the main tackle.

If the sheers are required to lift a 25 ton gun, two main tackles are used, with crab for each, and instead of the 8-fathom chain for sling, two of 12 fathoms each.

Derrick.

A derrick is used for raising heavy sheers, and consists of one spar 35′ long and 12″ in diameter at the foot, with shoe for foot, tackle, &c., viz.: **Derrick.**

25 fathoms of 4½″ tarred rope for each guy (4 in all).
Four lashing ropes, 5 fathoms of 4″ white rope.

---

* It is proposed to fit the ends of 45′ and 60′ spars with rings and caps, and connect them for use by a bolt with shoulders, upon which the main tackle is suspended by chains, and to use a chain sling.

† In lieu of these, wire rope in 30′ lengths is now to be adopted.

Six lashing ropes, 5 fathoms of $2\frac{1}{2}''$ white rope.
One „ 10 „ $2''$ „
Two foot ropes 15 „ $3\frac{1}{2}''$ „
One gasket, 3 fathoms of $6''$ white rope.
Four selvagees.
Spun yarn, 1 lb.
Four luff tackles.
Two $18''$ snatch blocks.

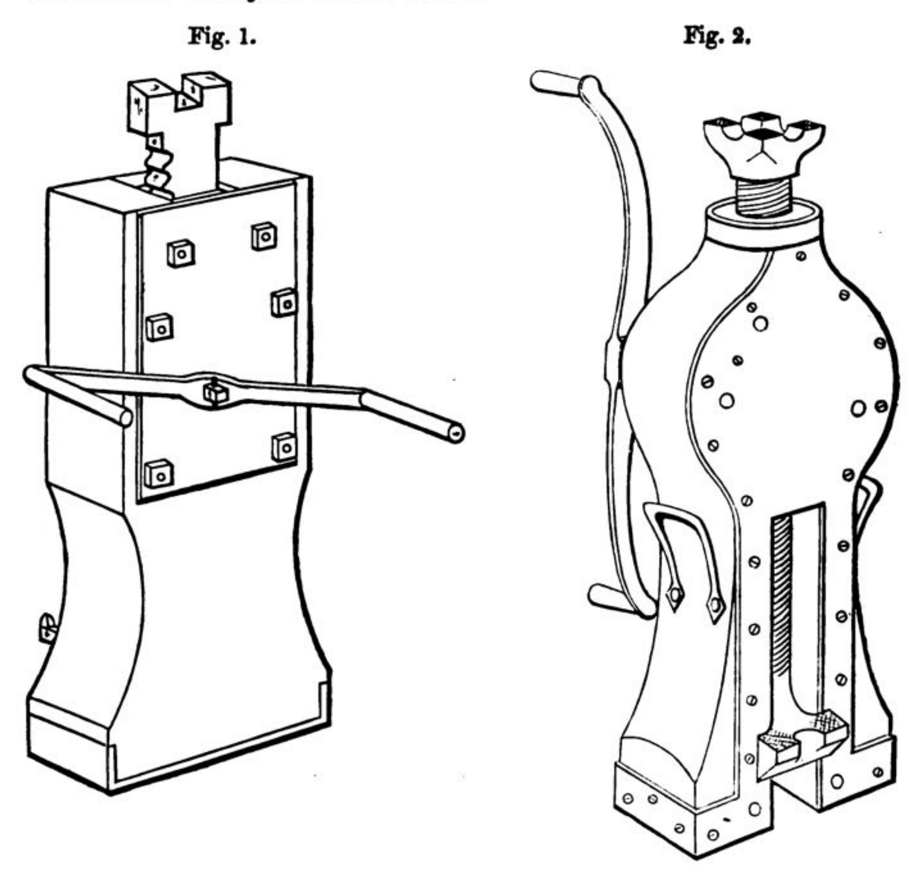
Lifting Jacks.

Lifting jacks. The lifting jacks used for garrison service are, the screw jack with ratchet head and lever, the rack and pinion jack, Haley's jack, and Tangye's hydraulic jack.

Screw. (R.C.D. photolithograph, 75.) The screw jack has already been described in the siege equipment; it will lift 5 tons.

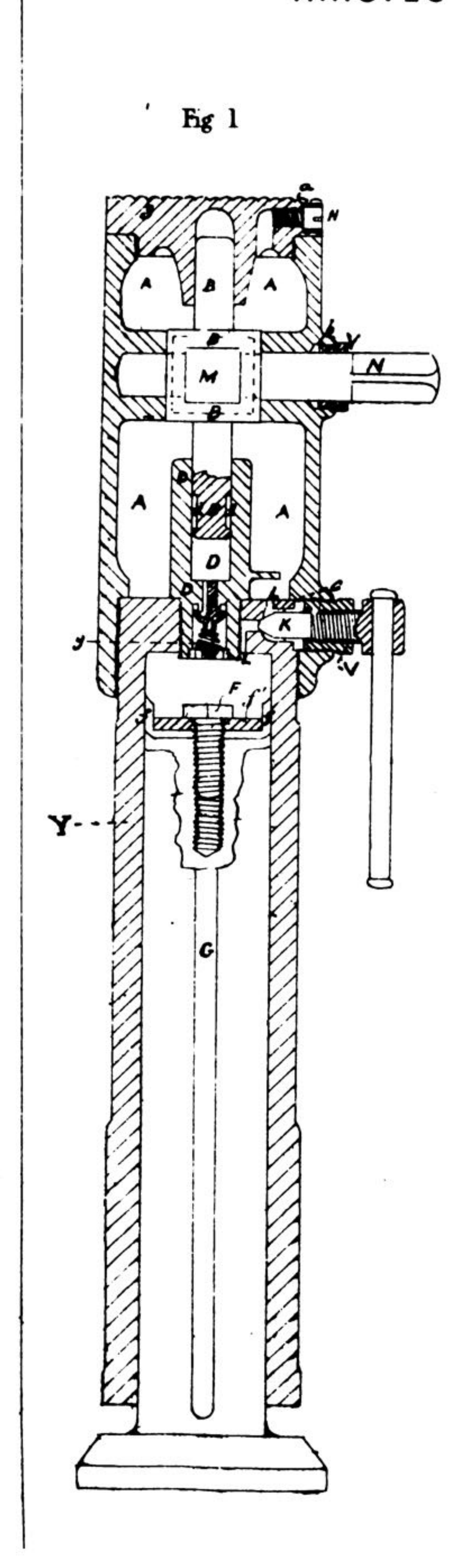
Rack and pinion. The rack and pinion jack, Fig. 1, consists of a vertical rack working in a block of elm, and taking the weight as in the screw jack, either on the top or on a claw at the lower end. The bar is raised or lowered by toothed gear inside the block, which is turned by a winch handle on the outside. The jack will lift 3 tons.

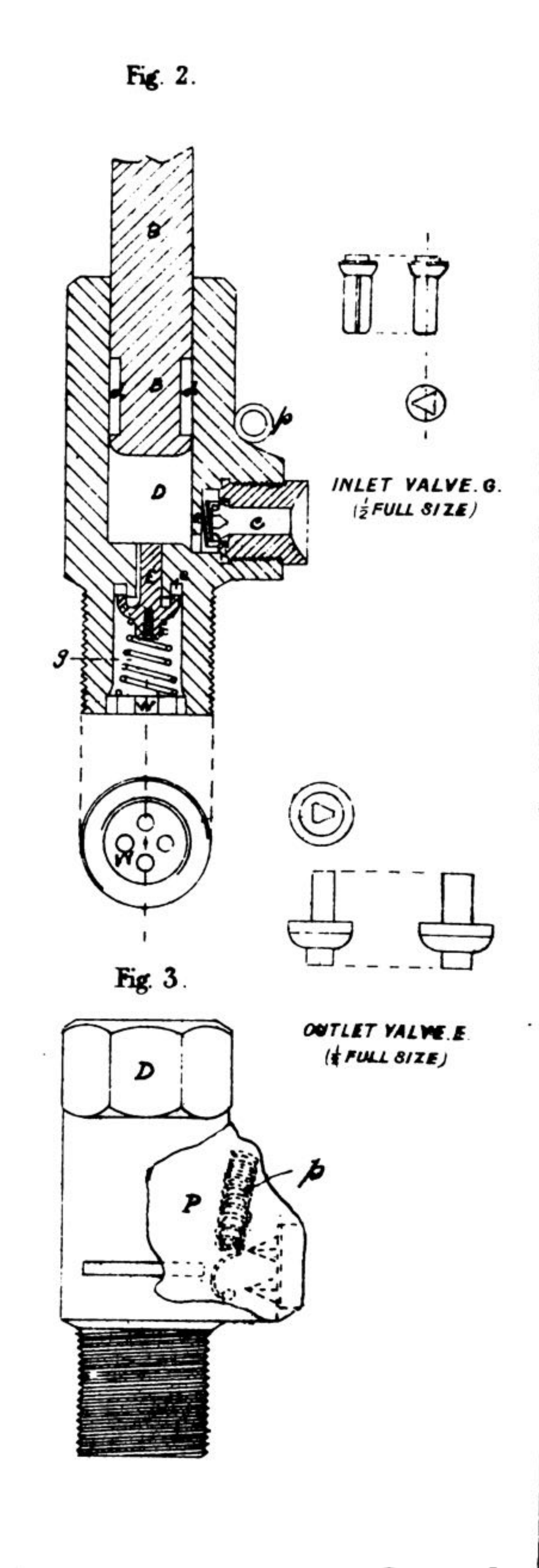
Fig. 1. Fig. 2.



Haley's. Haley's jack, Fig. 2, consists of a vertical screw working in a block of elm, and taking the weight as in the preceding. The screw passes through a metal nut with ratchet collar; in the latter a worm wheel, which is turned by a winch on the outside, gears. Haley's jacks vary in power from 2 to 20 tons.

TANGYE'S HYDRAULIC JACK.





The hydraulic jack, Plate XXV., Fig. 1, consists of the following principal parts, namely:—a ram G, a cylinder Y, a reservoir A, and a pump D: taking the 10 ton jack for illustration, the arrangement, &c., is as follows:—

The hydraulic jack. (R.C.D. photolithograph, 79.)

The ram is of wrought iron, cylindrical, with an oblong base upon which it stands.

The cylinder is also of wrought iron; it fits over and slides upon the ram; on its lower extremity a claw is formed to take the weight if required, and at the same end there is also a feather on the inside held by a screw, to work in a slot along the ram.

The reservoir is of cast iron, square, with round corners, in horizontal section of the body; it screws upon the upper end of the cylinder, and is closed by a screw cap *s*, at the top, upon which the weight to be raised can rest.

The pump, Fig. 2, is of metal, its lower end closed by a screw plug W, with four passages in it, and screws into the top of the cylinder, standing up therefore in the middle of the reservoir: in the bottom is an outlet valve E, and in the side an inlet valve C. The plunger B of the pump, also of metal, is worked by a spindle N with a camb M, and is guided by its upper end being prolonged into a recess in the cap of the reservoir. The crank spindle is supported in bearings formed in the sides of the reservoir, and is moved by a lever handle on the outside.

The action is as follows:—The reservoir being filled with water,* or nearly so, and a screw plug H for the purpose in the top loosened to admit air, when the plunger of the pump is raised water is drawn into the latter from the reservoir, through the inlet valve, the outlet valve being at the same time closed; the plunger being then forced down, the inlet valve is closed, and the water forced out through the outlet valve upon the head of the ram. Having here no escape, and the ram resting on the ground, to make room for itself, it pushes the reservoir and cylinder upwards, with the weight upon them, exerting a force as much greater than the pressure of the plunger as the area of the top of the ram is greater than the area of the bottom of the plunger.

To lower a load it is only necessary to allow of the escape of the water from above the ram; to do this a screw plug K (or relief valve), which closes a passage L for the purpose, is loosened, by means of its lever handle, and allows the water to flow back to the reservoir.

In order to make water-tight joints where the lever spindle and lowering screw plug enter the reservoir, there is round each a metal packing gland, V, V^1, with leather washer underneath, *b*, *c*; a similar washer *a* is also placed under the air screw.

To make a close joint between the ram and the cylinder, a cup-shaped leather packing *f*, is secured upon the former by a washer f^1 and screw F.

The outlet valve of the pump has a leather seating *e*, on which it is kept by a spring *g*, and round the plunger another leather packing *d*, is fitted.

The inlet valve of the pump has a metal seating, and is not liable to get out of order: it is protected from the ingress of dirt by a wire gauze, P, Fig. 3, soldered over it, and kept out from it by a spring *p*.

The leather packings require frequent renewal: to get at the plunger, the cap being removed from the reservoir, a securing screw in the crank is removed, when the spindle and plunger are free; to get at the

---

* Water mixed with methylated spirit, in the proportion of one part spirit to two parts water, is now proposed in lieu.

packing of the outlet valve the pump must then be unscrewed (which is easier done if the reservoir be first taken off the cylinder, for which purpose the lowering plug must be withdrawn,) and the screw plug in its lower end taken out.

To renew the packing on the ram, it is only necessary to set free the feather in the cylinder, when the latter can be lifted off, and to get at the other packings, the glands have only to be unscrewed.

For transport, the plug in the cap is tightened up by means of the pointed end of the lever handle, all the water being first collected in the reservoir.

The jack should always be kept filled, whether in use or in store, but requires to be cleaned occasionally, and to be worked at regular intervals in order to keep it in good order. In cold weather if water only (unmixed with spirit) is used in the jack, the latter when not in use should be stored in a warm room to prevent the water freezing.

Hydraulic jacks vary in power from 4 to 20 tons; the power of each is stamped upon it.

CHAPTER XIV.—MISCELLANEOUS ARTICLES.

Cartridge cases.

Cartridge cases are distinguished by numbers from 1 to 7, and by letters from A to F.

They are made of leather for S.B. and B.L.R. guns, and also for land service for M.L.R. guns, up to the 9″ (inclusive). The leather used is "crop butt," and is sewn with copper wire. Each case is fitted with a cover of block leather, and with a leather-covered rope handle. For M.L.R. guns, the cases are strengthened with bands and copper rivets, and have two handles instead of one. The following table shows the guns for which each nature of leather case is intended:—

Nature of Case.	Guns with which used.	Weight. lbs.	ozs.
1	10″ S.B. gun, 10″ and 13″ mortar	3	12
2	7″ B.L.R. and 68 and 56-prs. S.B.	5	10
3	8″ S.B.	4	0
4	32-prs., 56 to 63 cwt. S.B., 40-pr. B.L.R., 64-pr. and 80-pr. M.L.R.	3	0
5	32-pr. of 32 cwt. S.B., and 24-pr. S.B. of 50 and 48 cwt.	2	12
6	8″ and 5½″ mortars	2	4
7	20-pr. B.L.R., and S.B. guns under 24-pr.	2	5
*A.	7″ M.L.R.	5	12
†C.	9″ M.L.R.	7	5

* Now increased in length 4″, on account of increase of charge.
† B. is size for 8-inch M.L.R.

For the 10″ M.L.R. gun and upwards, for land service, cartridge cases are made of Clarkson's material. They are each fitted, in addition

to a leather handle over the top, with two handles at the side for carrying horizontally. They are as follows:—

Nature of Case.	Guns with which used.	Weight.
		lbs. ozs.
D.	10″ M.L.R. of 18 tons - - - -	9 8
F.	12″ M.L.R. of 25 tons - - - -	10 3
G.	12″ M.L.R. of 35 tons - - - -	11 0

Covers for vent slots. Covers for vent slots of B.L.R. guns are of canvass, waterproofed, lined with serge, and attached to a hollow elm block, which enters the slot. They are fitted with straps to secure them.

Fids. Fids for mounting and dismounting purposes are of beech or elm; they are fitted with a rope grummet, and have the nature of the gun for which intended stamped upon them.

Gallon measure for hydraulic buffer. The gallon measure for the hydraulic buffer is a tin measure graduated and fitted with metal cock.

Garlands. Shot garlands are formed of four lengths of angle iron, which overlap each other, and are secured by pins. The pins are universal, and the size of any garland may be increased by connecting additional lengths.

Garlands for foreign stations are usually made of wood on the spot.

Gaskets. A gasket is a flat plaited cord, an eye at one extremity, and the other usually tapered off. It is made from rope of any size required.

Gauges for sponge heads. Cast-iron hollow cylinders are made as gauges to guide the examination and clipping of sponge heads. They are only issued for the 7″ and 9″ M.L.R.

Gun brushes. Gun brushes are used for cleaning the bores of M.L.R. guns; the heads are conical in form, of elm, with Piasaba grass secured in them by marine glue. The staves are tapered, and of such length that the total length of the brush is the same as that of the sponge of the 80-pr., but in higher natures, 12″ longer. The same brush serves for the 80-pr. and for all the 64-prs.

Handspikes. Handspikes are of several descriptions, viz.:—

Common. "Common" handspikes are of ash, the lower ends square and bevelled off at the point, and the upper portion oval in Mark II., round in Mark I. They are of 6′ in length for use with guns of 80 cwt. and under, and also with the 7″ B.L.R. of 82 cwt. For use with guns above 80 cwt., excepting the 7″ of 82 cwt., they are 7′ long.

Metal roller. "Roller" handspikes with metal trucks are used for running up wood sliding carriages on traversing platforms. They are of ash, 7′ long, and have at the large end a plate of iron with hook and pawl, and also two metal trucks, one on either side, and at the small end a fall of white rope.

Wood roller. "Roller" handspikes with wood trucks are used in running up rear chock carriages. They are 6′ in length, and are made of ash fitted into an iron socket, the latter having two flanges with two rollers of lignum vitæ working between them on an axle bolt, and secured by a split key. Upon the upper side of the socket a projecting knob is formed, which fits into the handspike iron on the carriage.

Iron-shod. "Iron-shod" handspikes are of ash, bevelled at the point and shod with iron; they are either 5′ or 4′ in length, and are used for traversing platforms.

Levers: iron pointed. Iron-pointed levers are of ash, with wrought-iron points; they are of two natures, viz. :—

4′ 0″ long, weight 10 lb., for use with guns under 25 tons weight. Marks II. and III. levers are stouter than Mark I., and therefore require larger sockets. The point in Marks I. and II. is rounded off, but in Mark III. straight, to prevent slipping.

5′ 6″ long, weight 12 lbs., for use with guns of 25 tons and upwards.

Wood, iron-shod, crow. Crow levers are of ash with an iron claw plate at the point; they are either 6′ or 7′ in length, and are used for drawing nails or bolts out of platforms.

Wood. Wooden levers are similar in shape to common handspikes, but not bevelled off at the point; they are of ash, 8′ long for use with the heavy iron gyn, and 12′ long for use with heavy sheers.

Mauls. Mauls for garrison service are iron-bound, the heads of elm or sabicu, and helves of ash. Mark II is now approved for garrison or field service.

Mortar caps. Mortar caps are made of canvass waterproofed.

Man harness. Harness for man draught is made of $2\frac{1}{2}$″ white rope, with a hook at one end and an eye at the other, and fitted with web loops to go over the men's shoulders, thonged to the rope at intervals of $3\frac{1}{2}$′.

The harness is "heavy" or "light"; the former is 21′ long and fitted with four double loops, the latter 17′ long and fitted with three loops.

Oil pan. The oil pan for use with the hydraulic buffer is of zinc, $4\frac{3}{4}$″ square by $1\frac{1}{4}$″ deep, to receive any drip from the gland; it is suspended from the buffer by two bands.

Packings. The leather packings used between the bands and the cylinder of the hydraulic buffer are 12″ long by 4″ wide, and of various thickness as may be required.

Pedestals. Pedestals for the support of the stoolbeds of carriages when the elevating screws are removed are of elm.

Picket posts. Picket posts are of ash* (Pattern II.) shod with an iron point and hooped at the head. For garrison service they are 5′, 6′, or 8′ long; those 6″ in diameter and over 5′ in length have a hole in the head to take the guide rod of the pile driver. Pattern I. are of oak, in other respects the same as II.

Rollers. Wood rollers are for mounting and shifting ordnance; they are of elm, 10″ in diameter, 6′ or 4′ long; 6″ in diameter, 6′ or 3′ long; 5″ in diameter, 3′ or $2\frac{1}{2}$′ long; and of sabicu, 5″ in diameter, 3′, $2\frac{1}{2}$′, 2′, 20″, or 14″ long. Besides these there are the oak rollers already mentioned used with sleighs.

Ropes: Parbuckling. "Parbuckling" ropes are of 4″ tarred rope, in lengths of 18, 15, or 12 fathoms, with an iron hook at one end.

Preventor. "Preventor" ropes are of $3\frac{1}{2}$″ white bolt rope, from 30′ to 40′ long, with a hook at one end.

Running-back. "Falls" for the tackle of the running-back gear are of 3″ white rope; for the 9″ and 10″ M.L.R. carriages, 10 fathoms long, and for the 11″, 13 fathoms. For the 12″ of 35 tons (experimental) the fall is $3\frac{1}{2}$″ rope, 12 fathoms.

Scotches. Wood scotches are of three sizes, large, medium, and small; they are made of elm.

Selvagees. A selvagee is formed of rope yarns laid in circles and marled together.

Slings. A sling is formed by splicing the ends of a length of white rope together. The length and size of rope used varies with the service for which the sling is required. Some slings are fitted with thimbles (see sheers).

---

* It is approved to use for 8 pickets, pitch pine instead of ash; such will be Mark III.

Skidding for mounting and dismounting purposes is of fir or oak of the following sizes, namely :— **Skidding.**

Fir, 15″ × 15″ × 20′ ; 12″ × 12″ × 20′ ; 9″ × 9″ × 20′ ; 8″ × 8″ × 14′ ; 12″ × 12″ × 6′ ; 12″ × 12″ × 4′. Oak, 12″ × 3″ × 6′ ; 12″ × 3″ × 4′ ; 6″ × 5″ × 5′ ; 9″ × 6″ × 3′ ; 9″ × 3″ × 3′ ; 6″ × 6″ × 3′ ; 4″ × 4″ × 3′ ; and 3″ × 3″ × 3′. Besides the foregoing, for dismounting a 25-ton gun with jacks there is a breech beam of oak 9″ × 20″ × 10′, a muzzle beam 9″ × 10″ × 10′ of oak, and for use with a 12-ton gun a breech beam 9″ × 15″ × 10′, also of oak.

Side arms for M.L. rifled guns are as follows :— **Side arms.**

Nature of Gun.	Sponge.		Rammer.		Wadhook.	
	Weight.	Total Length.	Weight.	Length from Face of Head to Mark.	Weight.	Length of Stave.
	lbs.	ft. in.	lbs.	ft. in.	lbs.	ft. in.
12″ M.L.R. of 35 tons	29	14 9½	48½	9 4	18	14 2
12″ M.L.R. of 25 tons, Nos. 1, 2, 3, and 4.	Mark I. 37½	13 4	46½	8 9¼	17	12 9
12″ M.L.R. of 25 tons	Mark II. 30	”				
11″ M.L.R. of 25 tons	28½	”	39½	—		
10″ M.L.R. of 18 tons	22	”	30	8 1		
9″ M.L.R. of 12 tons -	16	11 9½	16	7 0¾	11½	11 0
7″ M.L.R. of 7 tons -	12	11 9½	13	6 8		
Ditto, Moncrieff -	22½	11 9	24	11 9	—	—
80-pr. M.L.R. converted, of 5 tons.	9	*10 8¼	7¾	—	7	10 0
64-pr. M.L.R., I. and II.	8	†9 5	7	6 2¼		
” III. - / ” converted, of 71 cwt.	9	†9 11				
” converted, of 58 cwt.	8½	*10 2		6 8¼		

* Have same head.
† Have similar heads, longer, but of the same diameter, as sponges.

The sponge head is of elm covered with fleecy hosiery, for M.L. guns, glued and choked on with a string, and for B.L.R. guns with a coating of woven hemp and canvass tied on. For the 7″ M.L.R. and up, the total diameter of the head is ½″ less than the bore of the gun, while for the 80-pr. and below, the head is of the same diameter as the bore. The head is secured on its stave with a copper pin, and has the nature of gun for which it is intended marked upon it. The sponge staves are of ash,* except for the Moncrieff guns, when they are of tarred rope, and are made of such length that when the sponge is home to the bottom of the bore the end of the stave shall project 15″ from the muzzle. The B.L.R. sponge staves are marked with a copper ring to show when they are home in the powder chamber. **Sponges.**

The rammer head is of elm, cupped to allow of a wad being rammed home and recessed to protect the fuze; it is bound with copper, in the 9″ M.L.R. and upwards with two bands, and in the lower natures with one. In the former natures it is secured on the stave by a copper rivet, and in the latter by a wood pin. The rammer staves are of ash* or rock elm,* except for the Moncrieff guns, when they are of tarred rope, and are made of such length that the total length of the rammer is somewhat less than the total length of the sponge. The rammer staves of **Rammers.**

* In future to be varnished with knotting.

M.L. guns are marked by the insertion of a metal screw with rounded head at the point which meets the muzzle of the gun when a service charge and common shell is rammed home. The head of the screw only projects sufficiently to be felt, the lower part being countersunk.

The 10″, 11″, and 12″ rammer staves are each fitted with an iron band with loops, to which are attached guide ropes for use in loading. The ropes are of 2″ white, and of such a length as to reach the front of the carriage bracket when the rammer is placed over the head of the projectile and entered 3″ in the bore of the gun.

Wadhooks. The wadhook consists of a wrought-iron socket with worm head riveted on to a stave of ash.

Spanner, gland. This spanner is of the usual form, and intended for use in moving the packing gland of the hydraulic buffer, 12″ to 7″. It is made of malleable cast iron, and weighs $5\frac{3}{4}$ lbs.

Spanner, plug and cock. This is a small spanner of iron weighing 13 ozs., one end being formed to fit the plug and the other the cock of the hydraulic buffer.

Spanner, McMahon's. The McMahon spanner is similar to the knock-up wrench, but the lower claw is moved by a screw working in a rack formed on the back of the bar.

Sponge caps. Sponge caps are made of canvass, waterproofed, and have each a string to secure it over the sponge head.

Sponge buckets. Sponge buckets for garrison service are of wood with rope handles.

Stage, loading. The loading stage proposed for use with dwarf traversing platforms, "C" pivot, consists of a wooden platform (about $5' \times 3\frac{1}{2}'$) 3′ 7″ in height, fitted with four pair of small cast-iron trucks, flanged to run on racers. Weight 5·928 cwt.

Straps. Straps are of different sized rope, as required, and are similar to slings.

Tackle, oading. The "loading" tackle for 10″ M.L.R. guns and upwards, consists of a special double iron block with large eye attached, a single iron block with hook, and a fall of 2″ white rope $7\frac{1}{2}$ fathoms long.

Tackle, magazine. "Magazine" tackle consists of one single and one double block (8″ common wood with lignum vitæ sheaves and copper hooks) and a fall of $2\frac{1}{2}$″ white rope 14 fathoms long.

Other tackles, see Machines.

Tampeons. Tampeons for keeping wet out of the muzzles of guns for M.L.R. guns are made of elm, the part which enters the bore being covered with serge and strips of leather sewn upon it to enter the grooves. They are made partially hollow for lightness, and fitted on the outer end with a knob of iron as handle, and on the inner end with screw loops for the attachment of a junk wad. The 32-pr. S.B. tampeon with a reduced wad serves for the 64-pr. or 80-pr. M.L.R.; it has a ring instead of a knob.

Tampeons for B.L.R. guns are solid, and have neither leather strips nor screw loops, and a rope grummet instead of a knob.

Templates. Wood templates to guide the conversion of 32-pr. S.B. sponge heads to 64-pr. M.L.R. are plain boards recessed to show the correct shape of the head, viz., length, diameter, and cone.

Wad formers. Wad formers are issued to stations where grummet wads for M.L.R. guns are manufactured; they are flat circular pieces of wood, usually of mahogany, hollowed out and grooved, so that the correct length of rope for the rim of the wad and for the cross piece can be measured, and also the position of the latter ascertained.

Wrenches. The "general service knock-up" wrench consists of two claws on a bar, the upper one formed in one piece with the bar and the lower one sliding; the latter is fixed at any required distance from the upper by means of an iron wedge.

PART III.—NAVAL CARRIAGES.

CHAPTER I.—WOODEN CARRIAGES AND SLIDES (SHIP).

Carriages.

Naval wooden carriages are "common standing," "rear chock," and "sliding," the same as land service carriages, which they resemble in general construction. They are usually made of elm, except the axletrees or blocks, which are of oak, and they are always fitted with capsquares. Their stoolbeds are of elm; quoins of elm, African oak, or sabicu, and they are fitted with swing or depression blocks, which can be placed under the stoolbeds for giving great depression to the gun when required. The elevating screw used with them is either the "common cross-handled" or the "ratchet-headed."

The principal wooden carriages are as follows :—

Nature.	Standing.		Rear chock.		Sliding.	
	Weight.	Tonnage.	Weight.	Tonnage.	Weight.	Tonnage.
	cwt.	tons.	cwts.	tons.	cwts.	tons.
7″ B.L.R. - - -	—	—	—	—	15¾	2·013
64-pr. of 71 cwt., M.L.R., or 8″ of 65 cwt., S.B.	9¼	2·028	—	—	15¼	1·900
64-pr. of 64 cwt., M.L.R. -	Main deck 8½; Upper deck 8	Main deck 2·000; Upper deck 1·875	—	—	13½	1·925
64-pr. of 58 cwt., M.L.R., or 32-pr. of 58 cwt., S.B.	—	—	—	—	14¾	2·500
40-pr. B.L.R. - - -	*8¼	*2·013	—	—	14¼	2·375
20-pr. B.L.R., Mark II. -	—	—	4½	1·200	3	·300
10″ S.B. - - -	—	—	—	—	15¼	2·625
68-pr. of 95 cwt., S.B. - -	—	—	—	—	18⅓	2·013
8″ of 65 cwt., S.B. - -	9¼	2·030	—	—	13⅓	1·800
8″ of 54 cwt., S.B. - -	8¼	2·015	—	—	9¼	1·625
32-pr. of 58 or 56 cwt., S.B. -	9	†2·022	—	—	11¾	1·875
" of 50 or 45 cwt., S.B. -	8	2·000	—	—	—	—
" of 25 cwt., S.B. - -	—	—	4¾	1·028	—	—
24-pr. howitzer, S.B. - -	—	—	4¼	1·015	—	—

* If for upper deck (wedge gun) 6¾ cwt. and 1·5 tons.
† If for upper deck 2 cwt. less and ·625 less tonnage.

Standing Carriages.

Standing carriages.

The trucks of the standing carriages are of elm, and beneath the axletrees "fighting" blocks are secured, upon which the carriage can stand in the event of the trucks being damaged in action. There are two blocks beneath the rear axletree, one at each side, and one under the front axletree, which is hollowed out to permit any water on the deck flowing under it.



Rear Chock Carriages.

Rear chock carriages.

Rear chock carriages have trucks and a fighting block in front similar to standing carriages. Holes are made in the brackets of these carriages, bouched with metal, to receive a breeching rope.

Sliding Carriages.

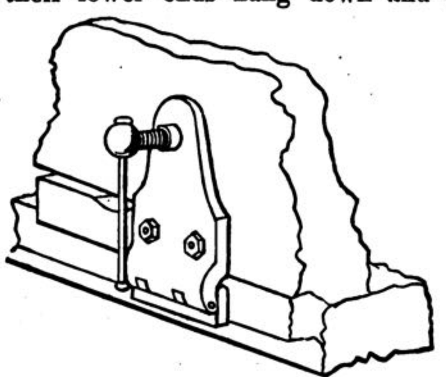
Sliding carriages. (*See* R.C.D. photolithographs, 80A and 81A.)

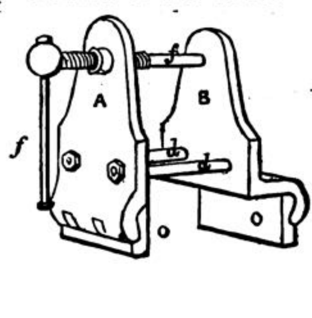
Sliding carriages, except the 20-pr., have the same width of guide block as land service wooden sliding carriages, so that they can be used on the dwarf or casemate wooden platform; they differ from the latter carriages not only in the height of the brackets, but in having rear as well as front rollers, holes for a breeching rope, and in being fitted with the "side plate" compressor (except the 32-pr. of 58 or 56 cwt., which has not yet been so fitted). In the 40-pr. and lower natures of sliding carriages the rear rollers run upon cranked axles, and are brought into play by means of iron-pointed levers, a socket to receive the lever being secured upon the inner end of each axle. In the 64-pr. and higher natures the axles of the rear rollers are eccentric, and have sockets for the iron-pointed levers, as before.

For a preventor rope a metal sheaf is let into the rear block, or in carriages for the 7″ and 68-pr. guns, two sheaves.

Naval sliding carriages, except the 20-pr., have a hole through the front block to take a transporting axle, in the same manner as the L.S. carriages.

The "side plate" compressor consists, on each bracket of the carriage, of two iron plates A, B, with hinged pieces O, O, on their ends; they are suspended on iron bolts, *d*, *d*, passing through the bracket, so that their lower ends hang down and overlap the side of the slide. The





outside plate is bouched in the upper end with a gun-metal nut, through which and the bracket an iron screw, with lever handle *f*, passes, the end of which abuts against the inner plate. According as the screw is turned, it forces the upper ends of the plates outwards from the brackets or permits them to move towards the brackets; in the first case compression is put on as the lower parts of the plates grip the side of the slide, and in the second the compression is relieved. To adapt the compressor to different carriages and slides, plates of different shapes, and blocks of wood under them of different thickness, are made use of.

The 20-pr. is a special carriage for chase guns in gunboats of the "Dwarf" and "Avon" class; it is similar to Mark II. upper boat carriage for the 9 or for the 12-pr. B.L.R. to be hereafter described, and is fitted with the same self-acting compressor that they have.*

* A hydraulic buffer will in future be substituted for this compressor (Mark III. L. of C. § 2617), and in future manufacture the wooden carriage will be superseded by one of iron with elevating gear the same as for the 20-pr. upper deck gun, page 180.

Slides.

Slides.

Wooden slides for sliding gun carriages are "heavy," "medium," or "light," as follows:—

	Nature.	Length.	Weight.	Tonnage.
			cwts.	tons.
Heavy	7″ B.L.R., or 68 pr., or 10″ S.B.	14	26½	3·200
		12½	25	2·850
	64-pr. M.L.R. of 71 cwt. (8″ converted)	14	19¾	2·625
		10½	16	1·950
	64-pr. M.L.R. of 64 cwt.	14	19¾	2·625
		12	19	2·350
		11½	18	2·175
		10½	16	1·950
	64-pr. of 58 cwt. (32-pr. converted)	14½	17¼	2·875
Medium	8″ S.B. of 65 cwt. or 54 cwt., and	12	15¼	2·750
	32-pr. S.B. of 58 or 56 cwt.	11	15	2·500
	40-pr. B.L.R.	11	14½	2·050
		10½	14¼	1·950
		10	13¾	1·875
Light	20-pr. B.L.R. chase, bow Mark II.	7½	3½	·082
	" " stern "	7½	5¾	·230

Heavy and medium slides. (*See* R.C.D. photolithographs, 80A and 81A.)

A heavy or medium slide consists of two sides of African oak connected by a head block of the same, and two under blocks of sabicu, while down the centre between the sides are placed two planks of sabicu.

The sides are parallel, 21″ apart, which, being the same distance as that between the sides of a wooden casemate platform, renders a slide convertible into such a platform. In the heavy slides the sides stand at a slope of 2½°.

The under blocks are shod with metal friction plates to take the bearing upon the racers.

A riband is attached to the outer surface of each side of some slides; this was originally placed there to adapt the slide for the "frame" compressor (now obsolete), and where it existed has been retained as bringing the side to a suitable width for the "side plate" compressor.

Heavy slides, except the 64-pr., are fitted with rollers for training upon, the rear rollers having eccentric axles, and being brought into play when required by iron-pointed levers in sockets upon the ends of the axles. When a slide is intended for a revolving slide a fifth roller, also upon an eccentric axle worked by an iron-pointed lever, is fitted in front of the front block at the centre of the slide, upon which the latter can be traversed.

In slides for the lighter natures of guns, to take the preventor rope there is a hole in the end of the left side, and at the end of the right a groove and a bollard. The standing end of the rope is held in the hole on the left, and the running end passed round the sheaf in the rear block of the carriage, and back through the groove on the right to the bollard. In the slides for the 7″ or 68-pr. whose carriages have two sheaves a whip block is hinged upon the end of the slide, and an iron sliding pin fitted upon the end of each side for the preventor rope.

All heavy or medium slides are fitted with metal flaps for housing or pivoting, pivot heads to receive pivot bars from the centre of the port, axletree bands for transporting, and shackles for the breeching rope and for traversing.

Light slides (for gunboats

The foregoing remarks do not apply to the 20-pr. slides, which are special for the carriages of chase guns in gunboats of the "Dwarf" and

of "Avon" class).

"Avon" class. These slides are similar to the 12-pr. boat slide, Mark II. to be hereafter described, but stouter and curved in front. The bow slide is raised 1″ at the friction plate in front and rear, and has a hole for the fighting bolt in the rear transom. The stern slide is raised 1″ at the friction plate in front, and 23″ in rear, by a fixed block, to which is attached in rear a joint, with flap and catch, for pivoting, and two iron loops for training. (See foot note, page 176).

(For gunboats of "Coquette" class.)

In the slides of 20-pr. guns for the sterns of gunboats of the "Coquette" class there is no high block, but a metal friction plate, making the stern slide the same as the bow.

CHAPTER II.—WROUGHT-IRON SLIDING GUN CARRIAGES (SHIP).

On the introduction of wrought-iron carriages the single-plate construction was adopted for sea as well as for land service, and, as already mentioned, the L.S. casemate carriage served for the S.S. with some special fitments, and with the sockets for the iron-pointed levers placed upon the inner instead of the outer extremities of the eccentric axles.

The first single-plate carriages issued to the navy were 7″ and 9″ M.L.R. of the 1st pattern, strengthened, the former, however, fitted with "side plate" instead of the "American" compressor. The remaining carriages were of the 2nd pattern, 7″, 8″, and 9″ M.L.R.; the 8″, which has not been mentioned with the L.S. carriages, being similar to the other two, and fitted with the Elswick compressor. The present naval sliding carriages are of the double-plate construction for natures of guns above the 7″ of 90 cwt., the ordinary service carriages being of the R.C.D. pattern, viz., 7″, 8″, and 9″, of which the first and last are really the L.S. carriages with special fitments, while the special carriages are of Captain Scott's pattern. For the 7″ of 90 cwt. and lower natures the carriages are formed of simple plates of iron, *i.e.*, single-plate, but without the bracket frame of the single-plate so called.

Naval iron carriages are painted before issue as follows: the bottom, inside, with one coat of red lead and one coat of Pulford's black over it; outside, two coats of red lead, and the remainder of the carriage, bearings and metal work excepted, receive two coats of Pulford's black.

Considering the original single-plate carriages as obsolete, the following table gives the weight, &c. of the present carriages:—

Table.

Nature.	Weight (with Gear).	Tonnage.	Diameter of Rollers.		Distance between Guides (outside to outside).	Brackets.	
			Front.	Rear.		Height to Axis of Trunnions from Slide.	Distance between inside of plates.
	cwts.	tons.	in.	in.	in.	in.	in.
20-pr. B.L.R., fitted for buffer.	5½	·264	—	—	21·325	18·25	15·500
*64-pr. M.L.R. of 71 cwt., fitted with E.O.C. compressor.	—	—	—	—	—	—	—
7″ M.L.R. of 90 cwt., fitted with E.O.C. compressor and winch gear.	24¼	1·396	10	6	28·96875	24·500	30·000

* Designed only.

Nature.	Weight (with Gear).	Tonnage.	Diameter of Rollers.		Distance between Guides (outside to outside).	Brackets.	
			Front.	Rear.		Height to Axis of Trunnions from Slide.	Distance between inside of plates.
	cwts.	tons.	in.	in.	in.	in.	in.
7" M.L.R. of 6½ tons, fitted with E.O.C. compressor and winch gear.	31¼	1·763	10	6	34·46875	31·125	35·625
8" M.L.R. of 9 tons, fitted with E.O.C. compressor and Scott's gear.	42¾	2·412	12	8	37·46875	31·250	38·350
9" M.L.R. of 12 tons, service pattern, fitted with E.O.C. compressor and Scott's gear.	46¾	2·668	12	8	41·96875	31·500	42·1875
9" M.L.R. of 12 tons, turret (double).	52½	3·25	—	—	—	—	—
9" M.L.R. of 12 tons, turret (single).	53¼	3·25	—	—	—	—	—
9" M.L.R. of 12 tons, Scott's pattern, for "Sultan," fitted with bow compressor, &c.	40¼	2·050	10	7	43·25000	21·250	42·2500
10" M.L.R. of 18 tons, Scott's pattern, for "Sultan," fitted with bow compressor, &c.	80	3·785	13	7	49·46875	23·000	49·5000
10" M.L.R. of 18 tons, Scott's pattern, for gunboats of "Snake" class, fitted with bow compressor.	80	3·827	13	7	49·46875	23·000	49·50000
10" M.L.R. of 18 tons, turret, for "Hydra," fitted with bow compressor, &c.	188½	9·118	11	10	47·71875	31·5 41·5 48·5	47·71875
10" M.L.R. of 18 tons, turret, for "Rupert," fitted with bow compressor, &c.	189¼	9·118	11	10	47·71875	32·0 44·0 52·0	47·71875
12" M.L.R. of 25 tons, turret, for "Glatton," fitted with bow compressor, &c.	206¾	10·937	12	9	58·46875	34·0 45·0 51·5	57·00000
12" M.L.R. of 25 tons, for "Hotspur," Scott's pattern, with bow compressor, &c.	105½	5·241	11	9	59·96875	26·0	58·0625
12" M.L.R. of 35 tons, turret, for "Devastation," fitted with bow compressor, &c.	223¾	11·908	13	12	59·96875	32·0 45·75 52·75	58·0000
·45 Gatling gun carriage	4¼	—	—	—	—	—	—
·65 Gatling gun carriage	4½	—	—	—	—	—	—

20-pr. B.L.R. of 13 or 15 cwt. Carriage, Mark I., for Upper Decks of Iron-clad Ships.

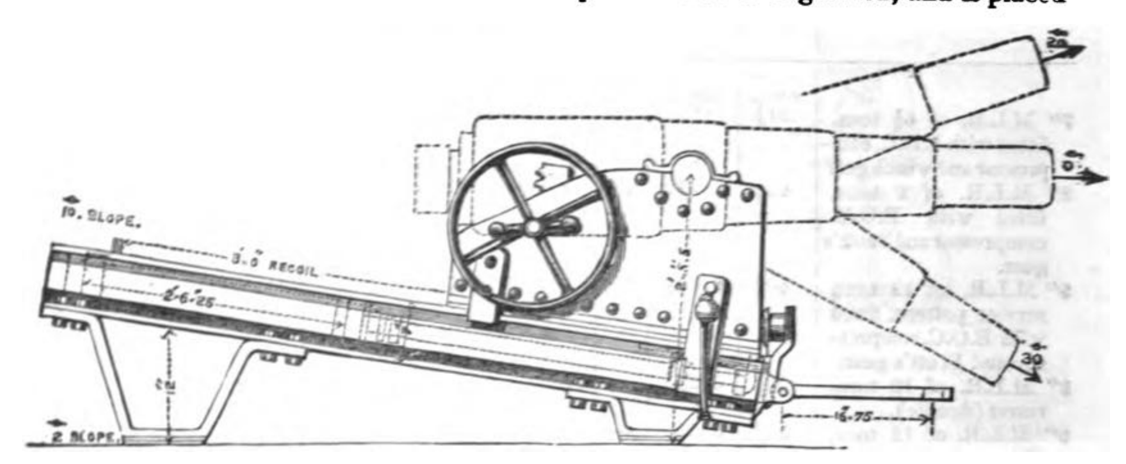
20-pr. B.L.R. of 13 or 15 cwt. carriage; Mark I. for upper decks.

The carriage consists of two brackets connected by a bottom plate and transom.

The brackets are of ½" plate, having each a trunnion plate of angle iron riveted in the trunnion hole; they are connected to the bottom plate

See R.C.D. photolithograph, 91A.)

by means of of tee iron, the latter being riveted through the tee along the bottom plate, the brackets standing upon the tee and being riveted to the web. The transom is of plate riveted to angle iron, and is placed



between the brackets immediately under the trunnion holes. The carriage has not rollers.

The elevating gear is fitted on the right side only, and consists of,—

Elevating arc.
Friction roller with spindle and nut.
Pinion with spindle, hand wheel, and jamming lever.

The hand wheel is of wrought iron, and serves instead of a capstan head, and iron-pointed lever. A metal bearing is bolted to the bracket to support the spindle. 20° of elevation or 30° depression can be given to the gun.

The carriage has on each bracket a front and rear eye bolt, a capsquare over the trunnion plate, and an iron stop on the inside in front.

It is fitted for the hydraulic buffer by a bracket bolted beneath the bottom plate, and by clips bolted, one to the outside of each bracket, in rear; also, to secure the carriage inboard when required, with a modification of the side plate compressor.

The compressor consists of two side plates, 4″ wide, one hung upon the outer side of each bracket towards the front by a single bolt, which passes from the left plate through to the right, outside of which plate there is a nut upon it, which can be tightened against the plate as desired, by means of a sliding lever. The plates bear against and catch under a piece of sabicu fixed along each side of the slide, so that according as they are tightened together by the nut they fix the carriage to the slide.

64-pr. M.L.R. of 71 cwt. Carriage. Mark I.

64-pr. M.L.R. of 71 cwt. carriage, Mark I.

The carriage now being designed for the 64-pr. is to be of similar construction to that for the 7″ of 90 cwt., next to be described. It will be fitted with the Elswick compressor, the same as that on the 7″ of 90 cwt., but with five compressor plates only, and with running back tackle instead of winch gear.

The elevating gear will be placed at one side of the carriage only.

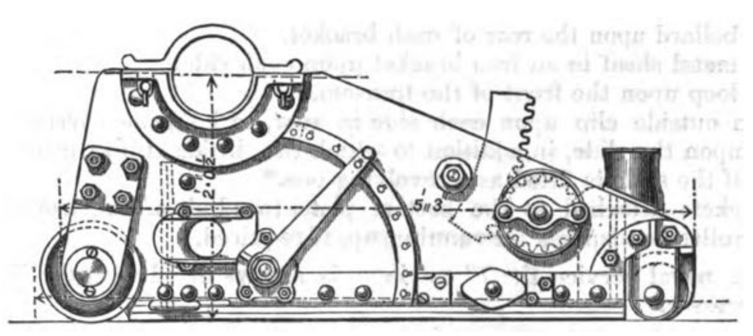
7″ M.L.R. of 90 cwt. Carriage. Mark I.

7″ M.L.R. of 90 cwt. carriage, Mark I.

The carriage is formed of two brackets, two transoms, and a bottom plate, and is fitted with front and rear metal rollers.

The brackets each consist of a single $\frac{3}{4}''$ plate with a piece of angle iron riveted along the lower edge on the outer side. A forged trunnion plate is riveted on the outer side of the bracket round the trunnion

(*See* R.C.D. photolitho-graph, 145.)



hole to give sufficient bearing for the trunnion of the gun; a metal bearing plate is attached by screws in the trunnion hole and an iron capsquare fitted over it.

The transoms are formed in the usual manner by riveting ·625" plate to angle iron frames, the front transom having also a piece of angle iron riveted along the lower edge in front.

The bottom plate is $\frac{3}{4}''$ thick; it is slotted for compressor plates and has angle iron guides riveted underneath, the ends of which are bent round to form stops.

The brackets stand upon the bottom plate, projecting beyond it in front and rear in order to receive the rollers; the transoms stand between the brackets along the front and rear of the plate, all the parts being riveted together. The axles of the front rollers are supported in small flanges bolted to the sides of the carriage, in which they rest in metal bearings secured by screws; they are put in from the outside and secured by keys. The axles of the rear rollers are eccentric, and connected by a bent bar with holes in it to take the iron-pointed levers; they rest in similar flanges to the front rollers and in the sides of the carriage, but without metal bearings. To remove the rear rollers or the connecting bar, it is necessary to take off the flanges supporting the axles. Stops are attached to the rear transom to prevent the rear rollers coming into action during the recoil of the carriage.

The carriage is fitted with the capstan head elevating gear on both sides, similar to that for L.S., but the friction roller spindle is secured by an hexagonal nut and pin. A metal bearing is bolted upon the outside of each bracket for the spindle of the pinion.

The compressor used with the carriage is the Elswick compressor, similar to the L.S. for double-plate carriages, metal bearings for the shafts being bolted to the outside of the brackets.

The carriage has also the following fittings; namely,

A loop riveted in front at each side upon the bottom plate.
An eyebolt on the centre of the front transom.
A hole in each bracket, with metal socket, to take the breeching rope.
A bollard upon each bracket in rear for a check rope.
A single metal sheaf, secured by pin and key in a small wrought-iron bracket bolted upon the side of the carriage, to take a running-back rope from the winch gear of the slide.
Four inside clip plates bolted to the under side of the bottom plate, to secure the carriage on its slide.

7″ M.L.R. of 6½ Tons Carriage. Mark I.

7″ M.L.R. of 6½ tons carriage, Mark I. (*See* R.C.D. photolithograph, 81B.)

This carriage is the same as the land service carriage for the 7″ of 7 tons, with the following additional fitments; namely,—

A bollard upon the rear of each bracket.

A metal sheaf in an iron bracket upon each side.

A loop upon the front of the transom.

An outside clip upon each side in rear, to hold the carriage down upon the slide, in addition to which the inside clip in front is used if the slide is fitted as a revolving one.*

Sockets attached to the bottom plate to admit of the use of metal roller handspikes for running up, if required.

For naval service the 7″ carriage is always fitted with the Elswick compressor.

8″ M.L.R. of 9 Tons Carriage. Mark I.

8″ M.L.R. of 9 tons carriage, Mark I.

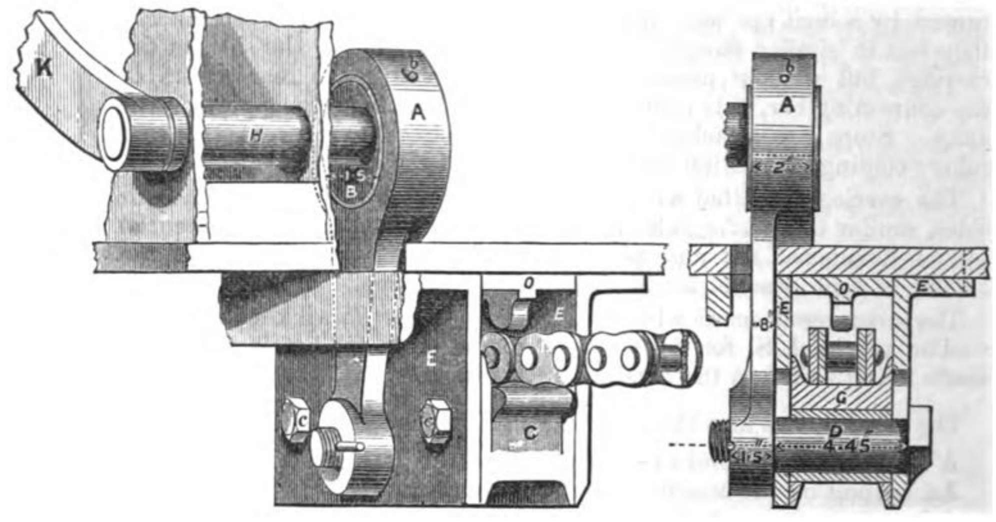
This carrriage is similar to the preceding, and like it has always the Elswick compressor, but is not fitted for winch gear with bollards and sheaves on the brackets, and in it the socket brackets for roller handspikes are discontinued.

Instead of winch gear it is fitted with Capt. Scott's nipping gear for attaching the carriage to a revolving endless chain on the slide, by which, therefore, it can be run in or out.

The gear consists of the following parts; viz.:—

A movable iron block C, held by two bolts *c, c,* passing through elongated holes in it, between two small brackets E, E, bolted beneath the bottom plate to the left rear of the carriage.

A link A, attached to the block by a bolt D, with keep pin, the bolt passing through elongated holes in the brackets of the block.



An eccentric B, which works in the top of the link, and is secured in it by a screw *b*; the shaft H passes through a metal bearing in the left side of the carriage, and has a bent lever K, by which it is worked, secured upon its outer end by a keep pin.

* For the use of front and rear holding-down clips generally, *see* L. of C. § 1987.

A stirrup F (not shown in Fig.), attached to the rear of the block, by screws.
A sprocket plate O, attached to the bottom of the carriage between the brackets of the block.

The endless chain of the slide passes through the stirrup, over the block, and under the sprocket plate, consequently, when the lever of the eccentric is moved to the rear and the block so raised, the chain is jammed by the latter against the teeth of the sprocket plate, which catch in it and fix the carriage to the chain. On the lever, however, being released, the block falls by its own weight, its stirrup carrying the chain down with it, and consequently freeing the carriage from the latter.

In the nipping gear first approved the block was wider and there were two links and eccentrics; this was superseded by the present pattern, as it interfered with the elevation of the gun and recoil of the carriage.

9″ M.L.R. of 12 Tons Carriage. Mark I. (Service Pattern).

9″ M.L.R. of 12 tons carriage, Mark I.

This is the same as the 9″ carriage for land service, fitted with the Elswick compressor, the capstan head elevating gear, and the axles of the rear rollers united by a connecting bar. In addition it has the fitments special to the sea service, similar to those of the 8-inch carriage, but with nipping gear on each side.

9″ M.L.R. of 12 Tons Turret Carriages. Mark I.

9″ M.L.R. of 12 tons turret carriage, Mark I.

9″ turret carriages were issued to the "Royal Sovereign" and "Scorpion" of two descriptions, termed "double" and "single," the former for a turret in which two guns were mounted, and the latter for a turret in which one gun only was mounted. The two descriptions differ merely in the arrangement of the gear, necessitated by the confined space between the carriages in the double turret.

The carriage itself is similar to the service pattern broadside carriage, but with much higher brackets, and the Elswick compressor differently arranged, namely, with the plates hung close to the brackets, four at each side, instead of in the middle of the carriage, and the rocking levers worked by a single shaft with hand wheels; by this arrangement compression is put on by each rocking lever pressing the plates and bars upon its own side against the slide.

The elevating gear is similar to the capstan head gear, but worked by hand wheels instead of by iron-pointed levers.

The rear rollers run upon an eccentric shaft, and are thrown into gear by levers with tackles on the ends of the shaft outside the brackets.

The carriage is fitted with nipping gear, outside holding-down clips, and buffers upon the front transom.

In carriages for double turrets the compressor hand wheel, lever of the eccentric shaft, and elevating hand wheel are dispensed with upon the contiguous sides, and a jamming lever with long arm is substituted for the ordinary one.

Similar carriages to those for the "Royal Sovereign" were issued to the "Prince Albert," but fitted with the hydraulic buffer and bow compressor (to be hereafter described) instead of the Elswick compressor. The hydraulic buffer is the same as for land service, but for use filled with 11½ gallons of oil.

9″ M.L.R. of 12 Tons Carriage. Mark I. (Scott's Pattern), Special for Ships of the "Sultan" Class.

9″ M.L.R. of 12 tons carriage, Mark I., for "Sultan." (*See* R.C.D. photolithograph, 87.)

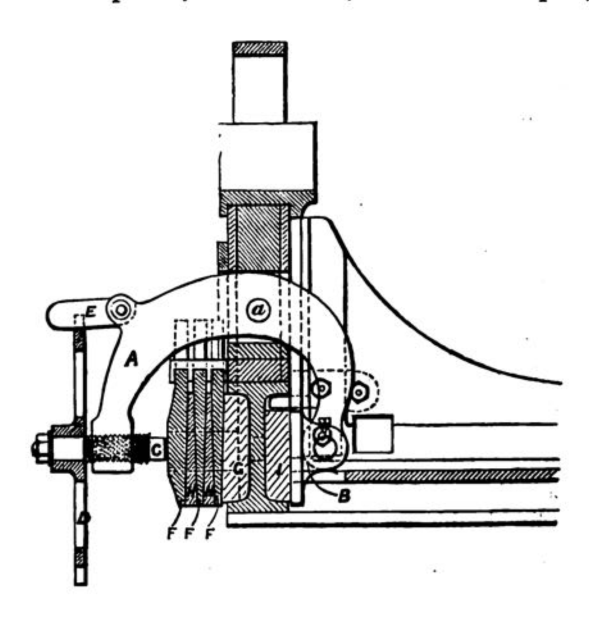
The main peculiarity of Capt. Scott's construction of carriage and slide consists in the former being low and the latter high as compared to the service pattern, while to admit of high elevation being given to the gun when required, the bottom of the carriage is well-shaped and lies between the sides of the slide.

The 9″ carriage consists of two long low brackets of the double-plate construction, but with cast-iron instead of wrought-iron frames, $4\frac{1}{2}$″ in width (the plates $\frac{1}{2}$″ thick); the inner plates project considerably beyond the under sides of the frames, and form the sides of the well; to them the bottom plate, $\frac{3}{4}$″ thick, is attached by means of angle iron, while the transoms fill in the ends and complete the well.

The front and rear rollers are completely hidden in their recesses in the brackets; the eccentric axles of the rear rollers are formed on the same shaft, which is round, bent in the middle, and has the usual socket holes for the iron-pointed levers. The shaft is held in each bracket in sliding pieces held by bolts, one piece sliding in the inner and the other in the outer plates of the bracket, the plates being strengthened by overlapping pieces riveted to them. As the inner sliding piece cannot be placed from the end of the shaft over the eccentric, it has a slot instead of a hole to receive the shaft, which is then secured in it by a small clip with two bolts. To remove the shaft from the carriage the clips are first taken off, after which the bolts of the sliding pieces being taken out, the latter, with the shaft, are drawn to the rear and the shaft freed from them.

The elevating gear is the "capstan head," a friction collar being added on the spindle between the side and the capstan head.

The compressor fitted to the carriage is that known as the "bow" compressor. It comprises, on each side, a bow or cramp A, pivoted at



the centre by a pin a, secured by a keep screw, in a metal bearing bolted to the outside of the bracket, so that one arm projects inside the carriage through the bracket. To the end of the inner arm a plate B is hinged by a pin, secured by a collar and keep pin, while the end of the outer holds an adjusting screw C, with a wheel D secured by a collar and

nut, by which the screw is worked. The wheel* is notched to take a pawl E for holding it in any required position, the pawl being secured by a pin, with collar and keep key upon the upper part of the arm; it is fitted with two handles (the front double and the rear single, not shown in Fig.) secured by thumbscrews, by which it is turned, and has a brass arc fixed upon it, graduated in degress from 0 to 6 each way, by which the amount of compression is marked. Two projecting pieces are attached to the side of the carriage to support the compressor plates, which hang upon them in such a position that the centre of each plate comes opposite to the adjusting screw; the plates F, F, F, are three in number, the outer one being thicker than the other two which are tapering. When the carriage is mounted on its slide, the tapering plates lie between the side of the slide which is filled in with wood G, and the compressor bars H, which are also tapered to correspond, while the thick plate hangs outside the outer bar, the adjusting screw touching it, and the plate upon the inner arm of the cramp bears against the inner side of the slide, which is also filled in with wood I. By this arrangement, when the screw is tightened it jams the plates and bars, together with the side of the slide, between itself and the end of the inner arm, and so, more or less, fixes the carriage to the slide.

The advantage of this form of compressor is, that when once set, it is self-acting, going out of action by reason of the taper of the plates and bars when the carriage is raised upon its rear rollers, and coming into action by the weight of the gun and carriage when the rollers are released.

The carriage is fitted with nipping gear on the left side only, but one running-in and out chain being used; the brackets for the block of the gear are bolted upon instead of beneath the bottom plate as the upper return of the chain passes through the well.

An eye bolt is fitted upon the top of each cheek of the carriage in rear, and a buffer block upon each transom, that upon the front transom being iron bound; holding-down clips are also bolted upon the latter transom.

10″ M.L.R. of 18 Tons Carriage. Mark I. (Scott's Pattern), Special for Ships of the "Sultan" Class.†

10″ M.L.R. of 18 tons carriage, Mark I., for "Sultan." (*See* R.C.D. photolithographs, 88 and 88A.)

The 10″ carriage is of similar construction to the 9″ and fitted with the bow compressor, but has box-shaped transoms, which extend considerably below the lower edges of the brackets, and under which the bottom plate is riveted, completing the well.

The eccentric shaft for the rear rollers is formed in two parts connected in the centre of the carriage by a coupling cylinder with pins; the axle end of each part runs in a metal bearing secured by screws in the inner bracket plate. Upon the left, the shaft is fitted with a hydraulic jack for throwing the rollers into gear, and upon the right with a capstan head arrangement for the same purpose should the jack be damaged or out of order.

The jack is single action (in future double action will be used), and is attached to a crank upon the shaft by a pin which passes through the lower end of the ram and is secured by a key: the crank is fixed to the shaft by means of a feather and slot. The upper end of the jack is attached to the cheek of the carriage by the projecting arm of a small

* The wheel, pawl, cramp, and cramp bracket on one side of the carriage are each marked I., and on the other side II.

† Similar carriages are designed for vessels of the "Temeraire" class.

iron bracket bolted upon the top of the cheek, passing through an eye in the cap, and being secured by a collar and keep pin.

The capstan head arrangement upon the right of the shaft consists of a toothed quadrant attached to the former by a feather and slot, and by a securing screw; above the quadrant upon a spindle in the left cheek of the carriage there is a metal capstan head and spur pinion, in one, secured by collar and key. The pinion gears in the quadrant, so that by working the capstan head with an iron-pointed lever the shaft is turned and the rollers thrown into gear. Above the pinion on a spindle through the cheek of the carriage there is a pawl with handle, by which the pinion can be pawled and the rollers so retained in gear.

Nipping gear is fitted on both sides of the carriage; in the end of the nipping lever there is an eye from which a rope is led over a metal sheaf secured by a bolt and pin in a small metal bracket bolted upon the top of the cheek of the carriage.

A stop bolt, which on being dropped into any hole in the capstan head of the elevating gear will hold the latter, is fitted in a metal bracket bolted on the side of the carriage.

A metal bracket with loop to receive the breeching rope is bolted to the front of each cheek of the carriage, and on the side of the cheek there is one eyebolt; a buffer block is fitted upon the front transom, but none upon the rear.

10″ M.L.R. of 18 Tons Carriage. Mark I., (Scott's Pattern) for Gunboats of the "Snake" Class.

10″ M.L.R. of 18 tons carriage, Mark I., for gunboats of "Snake" class. (*See* R.C.D. photolithograph, 88B.)

This carriage is the same as the 10″ "Sultan" carriage, except that the well is deeper to allow of 12° of elevation being given to the gun, and the rear ends of the brackets are shortened by 4″ so as to allow of the gun being lowered beneath the upper deck through the well; further, the carriage is not fitted with nipping gear, but has instead, for running back, two metal sheaves attached to the rear transom, and again a stud is screwed into the bottom plate at each side to prevent the inside compressor plate becoming too much inclined when out of action, by which it would be liable to become jammed when set up.

10″ M.L.R. of 18 Tons Turret Carriage. Mark I., for Ships of the "Hydra" Class.

10″ M.L.R. of 18 tons turret carriage, Mark I., for "Hydra." (Plate XXVI.)

Turret carriages 10″ and upwards are constructed upon Captain Scott's plan modified to some extent: they are peculiar in being "right" or "left," one bracket being longer than the other, to suit the circular form of the turret, and further, in having an arrangement by which the trunnions of the gun can be placed at different heights in the carriage, thereby admitting of greater elevation or depression being given to the gun through a small port than otherwise could be. From the latter peculiarity the carriages are said to be "muzzle pivoting."

The 10″ carriage is composed of two brackets, four transoms, a bottom plate, and a saddle.

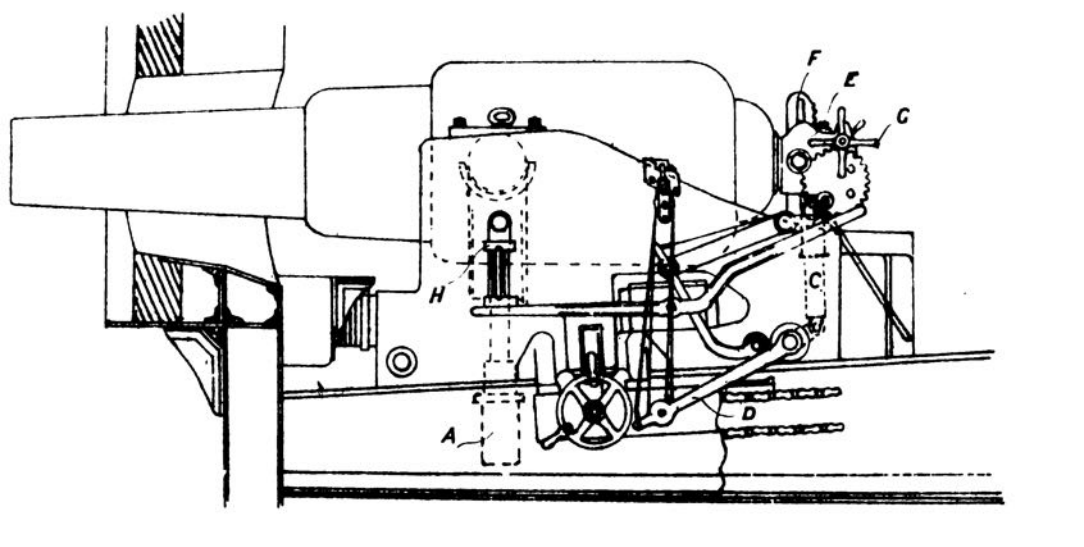
The frames of the brackets 6″ in width are formed in two parts, one much larger than the other; the larger is of cast iron and the smaller of wrought iron, the latter lies in the former and receives the saddle which carries the gun. The plates riveted over the frames are 1″ in thickness, the inner one being slotted to admit the saddle into the wrought-iron frame, and the outer one strengthened by a plate riveted at the upper part over the position of the ends of the same frame. As already stated, the brackets are of different length, that which is the outer when the

W. I. TURRET CARRIAGE.

"HYDRA" CLASS

FOR 10" GUNS OF 18 TONS

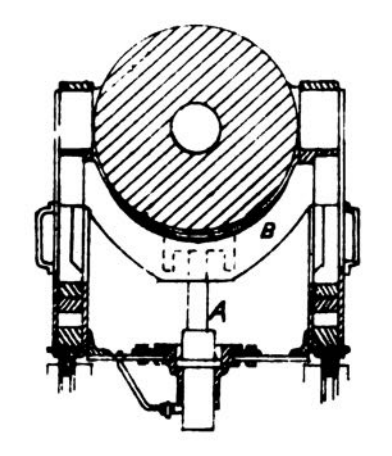
Scale about 1/60



SECTION SHEWING

HYDRAULIC LIFT A.

Scale about 1/60



Vincent Brooks Day & Son lith

gun is mounted in the turret being of course the shorter; they also project a little at the bottom in front beyond the line of the breast.

The three front transoms are low and formed in the usual manner of plate riveted to angle iron; they are riveted to the brackets and bottom plate, the first connects the projecting ends of the brackets, the second is placed to the front of the saddle slots, and the third to the rear of the same. The rear transom is of plate, stiffened by two horizontal ribs of angle iron, and connects the rear extremities of the brackets, being bent to suit their different length.

The well of the carriage is shallow, the sides of it are formed by angle iron riveted to the brackets, to which iron the bottom plate is in turn riveted; the latter is slotted at each side for the compressor plates.

The saddle B, Plate XXVI., is semi-circular in elevation to suit the form of the gun, and consists of three blocks, one at each end of cast steel and one in the centre of wrought iron, united by two plates lying on their sides; the whole is held together by bolts from plate to plate, some passing through the blocks and some not, the latter being collar bolts. The steel blocks have a trunnion hole in each, which is fitted with a metal bearing and with a capsquare; the latter is peculiar in form, being in fact a block of wrought iron fitted with a loop handle on the top and secured by four bolts each with two nuts.

The cylinder with the ram* A, for raising and lowering the gun in its saddle passes through the bottom plate immediately beneath the centre block of the saddle, against which the ram when acting takes a bearing; it is held in its position in a metal bracket which is secured by clips to the bottom plate.

The hydraulic by which the ram is moved is "double acting" and up to 40 tons: it is in the form of a small cast-iron box, which is bolted in a recess for the purpose in the outer cheek of the carriage towards the rear. The spindle for working the pump projects from the side of the box, and is fitted with a double lever; upon the top of the box is a short lever handle for moving the lowering valve, and from the front end passes a copper tube along the inside of the bracket through the bottom plate to the ram cylinder, which conveys the water from the › the latter, or in other words transmits the pressure.

Fig. 1 illustrates the jack for the lift: the parts, neglecting the lowering valve H, at one side of the vertical line O, P, correspond to those at the other, and consist of a pump R, the piston or plunger of which A (in one with the piston of the pump at the opposite side) is worked by the spindle C, with camb B, by a lever handle; an inlet valve F, with strainer D, to admit water to the pump from the reservoir X, X; an outlet valve G, through which the water is delivered from the pump; a passage H, through which the water passes to the tube leading to the ram cylinder, and a passage K, through which by the tube N, a connexion is made with the delivery passage at the opposite side. One delivery passage only is used, the left or right, according as the carriage is for the left or right side of the turret, the other being closed by a cap M. The action is as follows:—Suppose the pistons to be moving to the right, water is drawn into the pump on the left through the inlet valve, while water already in the pump on the right is forced through the outlet valve and delivery passage to the ram cylinder; when the pistons have completed the stroke to the right, the crank reverses their motion to the left, and when so moving water is drawn into the pump on the right by its inlet valve, while the water

* In the "Rupert" the ram is 3″ longer than in the "Hydra."



in the pump on the left is forced through the outlet valve by the tube **N** to the delivery passage on the right. In this manner a constant flow and pressure is kept up to the ram cylinder, and the jack is said to be "double acting," as whether the lever arms are moved up or down it is still acting. To lower the saddle and gun it is only necessary to open the passage *y* by the relief valve *n*, which permits of the return of the water from the ram cylinder to the reservoir. There is an air screw in the top of the reservoir, and an emptying hole closed by a screw in the front: in the side of the ram cylinder there is a check valve, that is, a valve similar to the outlet valve G, but with a small hole through the

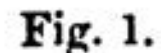
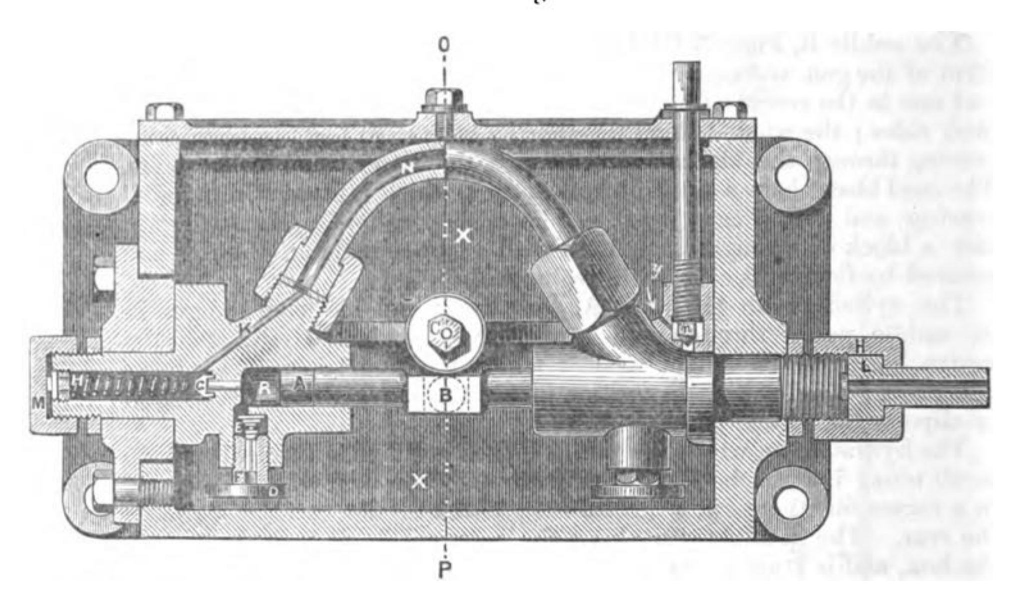


Fig. 1.



centre, by which the water can return to the reservoir, the valve being at the time on its seat.

At the low level the saddle rests upon the bottom of its slots in the brackets and at the middle or high level upon blocks of iron **H**, fitted each with a handle placed in the slots beneath it: the blocks are put in through a slot in the outer plate of each bracket. The following is the elevation and depression which can be given through the port at each level; namely, low level 7° to 13° of elevation and 0° depression; middle level, 7° elevation and 2° depression; high level, 3½° elevation and 6° depression.

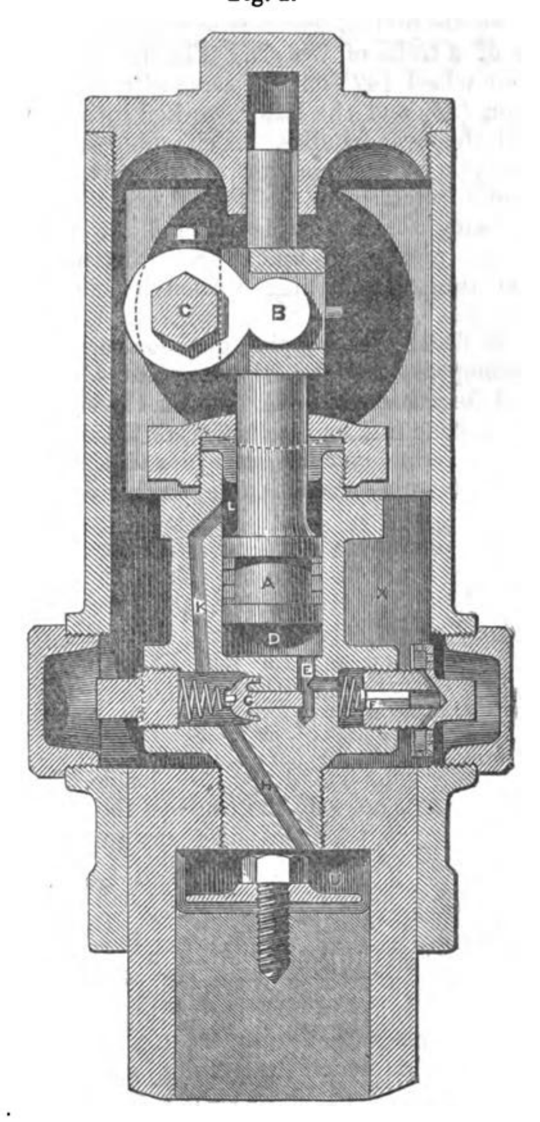
The rear rollers run upon an eccentric shaft formed in three pieces and supported in a metal bearing in each bracket plate and in another on the bottom plate. They are thrown into gear by a double-action hydraulic jack C, Plate XXVI., up to 10 tons, which is attached to a crank upon the eccentric shaft by a pin and to the outer bracket of the carriage by a trunnion projecting from its head, which enters and pivots in a small bracket bolted on the top of the cheek. The spindle of the pump crank passes out through the trunnion, and has the usual lever handle fitted to it.

Fig. 2 illustrates the jack for the eccentric rollers; the pump has a water space at each side of the piston, namely, L above, and D below; F is the inlet valve through which water is drawn from the reservoir X only during the upstroke; G is an outlet valve from the space below the piston, through which by the passage H water is delivered to the

ram cylinder U; from the space above the cylinder there is no outlet valve, but a free passage by K and L to the ram cylinder.

Suppose the space D full, and the piston at the end of its upstroke; on its being forced down by the camb B it presses the water through G by K to L, and by H to the ram cylinder, where it acts upon the ram. Upon the upstroke of the piston an annular surface of it, equal in area to half the surface of the lower end, presses upon the water in the space L, and forces it to the ram by the passages K and H; thus, in the upstroke as well as in the downstroke the ram is being acted upon and the work is continuous. The relief valve for lowering is not shown in the figure, as it stands perpendicular to the plane of the latter; it is similar to the relief valve in the ordinary single-action lifting jack. There is an air screw in the cap of the reservoir.

Fig. 2.



In case of any failure of the jack, a lever arm D is placed upon the eccentric axle outside the outer bracket of the carriage, having in its

extremity an eye and also three metal sheaves, while to a little bracket projecting from the top of the cheek of the carriage, a swivel block with four sheaves is fixed; a fall being attached to the eye of the lever and run through the sheaves, sufficient power can be obtained to bring the rollers into play.

The elevating gear consists of two cheek pieces E, Plate XXVI., of wrought iron secured one on each side of the cascable of the gun, by a bolt which passes through a metal bearing in the latter, and further held together by three collar bolts. In the cheek piece, which lies to the inner side of the carriage, there is a slot in which the elevating arc F slides. The lower end of the arc is pivoted upon the connecting bar of the rear roller axles, being prevented from having any lateral motion on the latter by being placed between one of the couplings and the supporting bracket. The arc being fixed, elevation or depression is given to the gun by, as it were, running the cascable of the latter down or up the arc by means of an arc pinion, which is worked by lever arms G through the intervention of a train of wheels. The train consists of a pinion (8 teeth) and spur wheel (47) on the same spindle, the former gearing into the arc pinion (15) and the latter worked by a pinion (10) on the same spindle with the lever handles. A clamping arrangement is added for securing the gun at any position on the arc, which consists of a horse-shoe cramp pivoted upon the top of one cheek piece, having in one end an adjusting screw with lever handle, while under each end, lying in the cheek piece and upon the arc, is a small friction segment, so that on the screw being turned it bites the arc between the friction segments.

The carriage is fitted with nipping gear for running-in and out, and with the bow compressor. The nipping gear is similar to that previously described for other carriages, but has the eccentric shafts united at the middle by a coupling, and both worked by one lever on the outer side of the carriage; the lever has an eye and single sheaf in its extremity for a fall, for which also a double block is attached to the side of the carriage.

The plates of the compressor at each side are four in number, all hung from supporting brackets upon the side of the carriage, one outside and three inside. Upon the inner side of the carriage two of the inside plates are, as in ordinary, tapering, but upon the outer side of the carriage, none are tapering, and the wheel for the adjusting screw of the latter is plane without notches to take a pawl; the compressor therefore upon the outer side of the carriage is not self-acting.

The carriage has also the following minor fitments; namely, a metal bearing for a breeching rope bolted upon the inside of the front transom, round which and through holes in the transom the rope passes; holding-down clips upon the front of the same transom; and in the upper part of the front of each bracket, a hole to receive a securing bolt.

10″ turret carriages of the same description as those of the "Hydra" were issued, previous to the "Hydra's," for the "Abyssinia" and "Magdala;" these carriages were fitted for additional jacks, by which the saddle could be moved in case of the failure of the central lift, and also with the hydraulic buffer in addition to the bow compressor.

A strong bearing was attached to the top of each bracket of the carriage on the outside, on which the pulling jack rested, while its ram projected through the bearing and was secured to the saddle by a bolt. To ensure uniformity of action the jack upon one side was connected, by a copper tube passing over the gun, with the jack on the other side. Such jacks are now considered unnecessary.

11″ or 12″ M.L.R. of 25 Tons Carriage. Mark I. (Scott's Pattern), for the "Hotspur."*

12″ M.L.R. of 25 tons carriage, Mark I., for the "Hotspur."

This carriage is similar to the 9″ carriage for the "Sultan," and is fitted with the bow compressor, but the sides of the well are not formed by the inner bracket plates, but are built up of pieces of plate and angle iron, so as to leave room between them and the slide for the compressor plates and bars, which, as in the last-described carriage, are placed upon the inner side of the slide. The plates are of the usual form, and the inside plate is pinned to the inner arm of the cramp.

The eccentric shaft is made in three parts, connected by couplings; the rollers are brought into gear by a capstan head arrangement on each side, similar to that fitted upon the right of the eccentric shaft of the 10″ carriage for the "Sultan;" but the capstan head and pinion are not in one, and the former is placed outside instead of inside the cheek of the carriage.

The spindles of the elevating gear are supported in metal brackets upon the top of the cheeks of the carriage, instead of passing through the latter.

The levers of the nipping gear are fitted each with tackle as in the 10″ turret carriage.

The carriage has also the following fittings; namely, metal brackets for the breeching rope in front, one on each side; two outside holding-down clips upon each bracket; and in rear, from one bracket to another, a piece of angle iron upon which to rest the wood tangent scale when used.

12″ M.L.R. of 25 Tons Turret Carriage, Mark I., for the "Glatton."

12″ M.L.R. of 25 tons turret carriage, Mark I., for the "Glatton."

This carriage is of slightly different form to that of the 10″ for the "Hydra;" the inner bracket plates project slightly below the frames, and the bottom of the well is formed by a bent plate which is attached to the bracket plates by angle iron. The lower parts of the brackets do not project to the front, though the front rollers do, and there are but three transoms.

The carriage is fitted with additional jacks for lifting the gun, as in the 10″ carriages for the "Abyssinia;" the nipping gear, &c. is also the same.

12″ M.L.R. of 35 Tons Turret Carriage, Mark I., for the "Devastation."

12″ M.L.R. of 35 tons turret carriage, Mark I., for the "Devastation."

The turret carriage for the "Devastation" is similar to that of the "Glatton," but the rear transom does not unite the ends of the brackets, but is placed from the end of the shorter across to the side of the longer and parallel to the other transoms.

The hydraulic lift for the saddle is not part of the carriage but of the ship, and instead of one ram there are two, one to act when the carriage is in the loading position, the other when it is run up.

The elevating gear differs from that of previously-described turret carriages in not being attached to the cascable of the gun, and in having an arrangement by which its level can be altered to correspond to that of the trunnions of the gun. The arrangement consists of a stout screw placed vertically inside the carriage on the inner side, worked up or down by a metal nut which is contained in an iron collar. The latter

* Similar carriages are designed for ships of the "Temeraire" class.

is held in a bracket bolted to the cheek of the carriage, and has upon its lower end a bevel pinion; into this pinion another pinion, of metal, gears, which is fixed upon a spindle passing through the side of the carriage, and worked by a winch handle upon the outside. The gear by which the gun is elevated or depressed is similar to that of the "Hydra" turret carriage, but has an additional wheel and pinion for gain of power; it is attached to the head of the vertical screw by a pin, and connected to the elevating arc by two bolts passing through a slot in the length of the latter, so that the attachment does not interfere with the motion of the arc, which is fixed to the breech of the gun. At low level the end of the vertical screw rests in a metal socket bolted upon the bottom plate, and at middle level on a bracket hinged to the side of the carriage.

The carriage is fitted with the bow compressor, nipping gear, &c., as in the carriage for the "Hydra," with the difference that in the compressor there are two outer plates instead of one upon each side.

·45 Gatling Gun Carriage.

·45 Gatling gun carriage.

This carriage resembles the field service Gatling carriage in the general form of the body, and is mounted upon special class 3′ 6″ Madras pattern wheels,* with a rounded tire 2″ wide, and having a track of 3′ 6½″.

The brackets are of ½″ plate; they are riveted to the axletree, and further connected to it, each by a stay of round iron; they are united by three collar bolts in their length, and at their points by a trail piece which lies between them, and has the usual eye formed in it; to give increased bearing on the ground a small piece of angle iron is riveted to each side of the point of the trail.

The axletree† is solid, its body bent down at the centre, to receive a bed upon which the gun lies.

The bed consists of a wrought-iron pedestal, the lower end of which rests upon the centre of the axletree, while a pin projecting from it passes through a hole in the latter and is secured beneath. Upon the upper end of the pedestal, in the direction of the longitudinal axis of the carriage, a bearing plate is bolted, to the under side of which a vertical quadrant or elevating arc is attached. The arc has teeth in its periphery, in which an endless screw worked by a hand wheel gears, so that by working the screw any required elevation or depression can be given to the bearing plate, and consequently to the gun above it. To admit of lateral motion being given to the gun, another bearing plate is placed upon the first, pivoted to the latter in front, and having a pin projecting from it working in a circular slot in the latter to the rear To give motion to the upper or trunnion plate, to which the gun is bolted, a worm wheel is attached to the upper end of the pin just mentioned above the plate, and a pinion to the lower end beneath the under plate. The worm wheel is worked as desired by an endless screw with hand wheel upon the upper plate at the left side, while the pinion gears into an arc attached to the under side of the under plate.

The gun is intended to fire from its carriage (height to centre of gun 3′), through a port with sill 18″ high, when 5° depression or 25° elevation can be given to it. It is also intended to be fired from the tops or from the gunwale of the ship, in which case it is removed with its bed from the carriage, and the bed placed in a socket for the purpose.

---

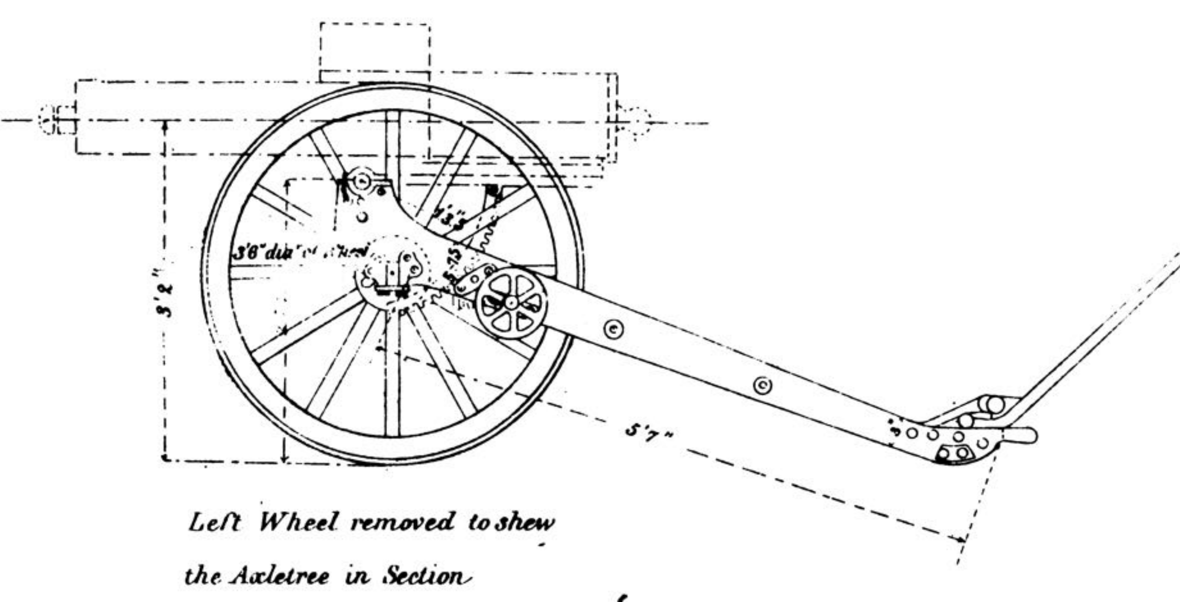
* Weight, each 88 lbs.

† This axletree belongs to the special class and has a length of arm of 7·988″.

W.I NAVAL TRAVELLING CARRIAGE

FOR 0.65" GATLING GUN

SCALE ½ INCH = 1 FOOT



Left Wheel removed to shew the Axletree in Section

The point of the trail is fitted with an iron traversing handspike of the Indian pattern.

·65 Gatling Gun Carriage.

·65 Gatling carriage. Plate XXVII.

The carriage designed for the ·65 Gatling gun is similar to the field Gatling carriage for the ·45 gun, but with the same track and wheels as the preceding. The brackets are of ½″ plate, and bent outwards to accommodate the width of the gun.

Elevation of 25° or depression of 30° can be given to the gun by means of an arc attached to the under side of the trunnion plate, which is worked by a worm wheel and screw fixed between the brackets, and driven by a hand wheel outside the left bracket.

CHAPTER III.—WROUGHT-IRON SLIDES (SHIP).

Wrought-iron naval slides, corresponding to the carriages, are of two patterns, namely, the ordinary service pattern and Captain Scott's pattern.

The service pattern is the same in general construction, whether for single or double-plate carriages; the former, namely, 7″, 8″, and 9″, are all the same width (34·5″) between the sides, though differing in other dimensions; the latter, also 7″, 8″, and 9″, are each of different width, the 7″ being the same as before, but the others wider; hence the 8″ and 9″ slides for single-plate carriages are termed "narrow," while those for double-plate carriages are termed "broad."

To agree with the carriages, the 7″ slides for the first pattern single-plate carriages were fitted for the side-plate compressors by having the space between the web and the flanges of the girder filled in with wood for the plates to bear against. The 8″ and 9″ narrow slides for the first pattern single-plate were fitted for the American compressor, in the same manner as the platforms, with wooden baulks down the centre; and all the narrow slides for second pattern single-plate carriages were fitted for the Elswick compressor, with bars down the centre.

Iron naval slides, before issue, are painted as follows:—The under parts with two coats of red lead; the remainder, except bearings and metal work, with two coats of Pulford's black. Metal work, except bearings, receive two coats of stone-colour paint.

Neglecting the slides for the original single-plate carriages, the following are those at present in the service:—

Nature.	Weight, with Gear.	Tonnage.	Diameter of Rollers (conical). Front.	Diameter of Rollers (conical). Rear.	Distance between Sides.	Length nominal.	Height to Axis of Gun, carriage run up.
	cwts.	tons.	ins. ins.	ins. ins.	ins.	ft. ins.	ins.
20-pr. B.L.R., fitted with buffer.	8¾	0·625	—	—	13·325	6 7½	29·5
64-pr. M.L.R. of 71 cwt., fitted with E.O.C. compressor.	—	—	—	—	—	10 6	40·0
7″ M.L.R. of 90 cwt., fitted with E.O.C. compressor and winch gear.	33¼*	2·648	6 × 5·269†	8 × 7·783‡	29·0	11 0	41·0

* If with traversing gear also, add 3 cwt. † For "Raleigh," 5·177. ‡ For "Raleigh," 7·774.



Nature.	Weight, with Gear.	Tonnage.	Diameter of Rollers (conical).		Distance between Sides.	Length, nominal.	Height to Axis of Gun, carriage run up.
			Front.	Rear.			
	cwts.	tons.	ins. ins.	ins. ins.	ins.	ft. ins.	ins.
7″ M.L.R. of 6½ tons, fitted with E.O.C. compressor and winch gear.	42	2·481	6 × 5·443	8 × 7·811	34·5	12 0	41·0
8″ M.L.R. of 9 tons, fitted with E.O.C. compressor and Scott's gear.	60	4·558	7 × 6·144	10 × 9·642	37·5	13 0	44·0
9″ M.L.R. of 12 tons, service pattern, fitted with E.O.C. compressor and Scott's gear.	*66½	†5·937	7 × 6·144	10 × 9·642	42·0	14 0	44·0
9″ M.L.R. of 12 tons, Scott's pattern, for "Sultan," fitted with bow compressor, &c.	‡64¾	7·139	8·5 × 7·146	11·5 × 10·855	43·375	12 6	44·0
10″ M.L.R. of 18 tons, Scott's pattern, for "Sultan," fitted with bow compressor, &c.	122	13·650	12 × 10	14 × 13	49·50	15 0	52·5
10″ M.L.R. of 18 tons, Scott's pattern, for gunboats of "Snake" class, fitted with bow compressor, &c.	§77½	5·475	—	—	49·50	15 0	39·0
12″ M.L.R. of 25 tons, for "Hotspur," Scott's pattern, with bow compressor, &c.	176½	10·227	12 × 9·887	16 × 14·926	60·00	15 5	60·0

* For "Lord Clyde," 70¼.
† For "Lord Clyde," 6·093.
‡ If with traversing gear only, deduct 2½ cwt.
§ With derrick.

20-pr. B.L.R. of 13 or 15 Cwt. Slide for Upper Decks of Iron-clad Ships. Mark I.

20-pr. B.L.R. of 13 or 15 cwt. slide, Mark I. (R.C.D. photo-lithograph, 91A.)

This slide (see Fig., page 180) consists of two sides of girder iron, 7″ deep by 4″ wide in the tee, connected by a transom of plate riveted to angle iron in front and in rear. The sides are supported each upon two forged brackets bolted beneath the girder, so as to stand at a slope of 10°. The front brackets are connected by a plate placed beneath them, underneath which metal friction plates are attached.

The slide has eye bolts in front and rear at each side, iron stops for the carriage on recoil, and two india-rubber buffers to receive it when run up; the latter are attached to stays for the purpose projecting upwards from the front transom. A batten of sabicu is bolted to the outer side of the web of each girder side for the compressor plate to bear against.

A pivot flap, in one piece, is attached to the head of the slide by a bolt, which passes through its ends and through a bracket bolted to the web of each girder side. The bolt is secured by a key.

The hydraulic buffer with which the slide is fitted rests upon two bearing plates across the platform, to which it is secured in the usual manner by holding-down bands.

The buffer is similar to that for L.S., but instead of having flange and cover, the former is dispensed with and the cover screws on to the front of the cylinder. The emptying cock is screwed into the cover and cylinder on the under side, instead of into the front of the cover, and the

plug into the cap on the upper side. The buffer weighs 2 qrs. 16 lbs., and admits of a recoil of 3′; its cylinder is 4″ in internal diameter, and for use receives 5 quarts of oil when the depth at the filling hole is $1\frac{3}{8}$″. The piston has four holes of ·562″ in diameter. The collar nut on the rod is placed 6″ to the rear of the bracket of the carriage when the connecting nut touches the latter, to allow of a slip of 6″ on recoil, before the resistance of the buffer begins, which maintains a recoil of 3′, as in the wood carriage and slide for the 20-pr. (upper deck, L. of C. § 1926), though the slide and buffer are shorter than before.

64-pr. M.L.R. of 71 Cwt. Slide. Mark I.

64-pr. M.L.R. slide, Mark I.

The slide now being designed for the 64-pr. will be similar to that for the 7″ of 90 cwt. next to be described, but supported on three blocks, built up of plate and angle iron, and with metal friction plates instead of rollers to take the bearing on the deck.

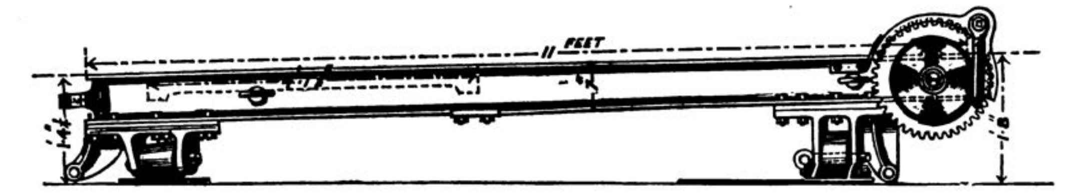
It is to be fitted with a traversing roller, being intended to be used with a chase gun, also with running back tackle instead of winch gear.

7″ M.L.R. of 90 Cwt. Slide. Mark I.

7″ M.L.R. of 90 cwt. slide, Mark I. (R.C.D. photo-lithograph, 145.)

This slide (see Fig.) consists of two sides connected by a transom, three bottom plates, and fitted with rollers secured in flanged feet.

The sides are of girder iron 7″ deep and 5″ wide in the flange, bent round to meet in front as in the 7″ L.S. platform: the transom is of angle iron and the bottom plates $\frac{3}{4}$″ thick.



The sides have a slope of $1\frac{1}{2}$° (in addition to 2° given by the deck), and are connected in front by plates lapping over their junction and bolted to them, the outer plate also serving as a bracket for the connexion of the pivot bars, while the inner forms the support for the front pin of the compressor bars. In rear the sides are connected by the transom, which is bolted to them. The front bottom plate is bolted beneath the head of the slide and the rear a little to the front of the transom. The centre bottom plate is attached by clips bolted to it.

The flanges for the rollers are bolted beneath the bottom plates immediately under the sides, packing pieces being placed between the rear plate and the rear flanges. To the latter flanges metal friction plates are bolted, which take the bearing on the racer when the rear rollers, which have eccentric axles, are not in action.

The rollers are secured upon 2″ axles, which are keyed upon the outer side; the axles of the rear rollers have, each, a loop formed on the inner extremity to receive the iron-pointed lever for throwing the roller into gear.*

* The rollers of slides for the "Raleigh" are stamped with the letter "R"; they are coned to the following radii, viz.: front 3′ $4\frac{3}{4}$″, rear 11′ $7\frac{1}{2}$″.

The slide is fitted in the usual manner for the Elswick compressor, the supporting pin for the bars being 2″ in diameter, and has also the following fitments, namely :—

Stops, for the carriage when run up, of wood, with 3″ india-rubber buffer rings on spindles with keys.

Stops, for the carriage on recoil, of iron, with 2½″ buffer rings.

Eye bolts, front and rear, on each side.

Foot planks of sabicu, bolted from the rear to the centre bottom plate.

Bollard with hook, bolted to the rear transom.

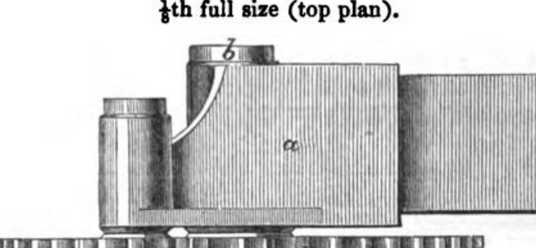
A metal flap hinged by a pin with key to a metal joint bolted beneath the front bottom plate ; this flap is intended for housing the slide inboard, and when not in use is held up by a catch on the head of the slide. A similar metal flap for pivoting is attached to another metal joint bolted beneath the rear bottom plate.

The pivot bars are attached by bolts with keep pins to the bracket, already mentioned for the purpose, upon the head of the slide.

Winch gear ; consisting, on each side, of a cast-iron spur wheel *d*, Fig. 1, and serpentine wheel, *c*, in one, secured by a collar and split

Fig. 1.

⅛th full size (top plan).



key on a gudgeon *b*, bolted to the side of the slide in rear ; the spur wheel is driven by a pinion *f*, secured by a collar and split key on a spindle *e*, the latter being held in a bracket bolted on the end of the slide and being worked by a winch handle *g*. A metal guard covers the spur wheel and pinion.

When the slide is required as a "revolving" slide it is further fitted with "traversing" gear, as follows :—a centre metal roller A, Fig. 2, with eccentric axle, is supported in a bracket beneath the front bottom plate ; on the end of the axle there is a bevel pinion B, into which another bevel pinion C upon a cross shaft gears ; the cross shaft is held in a bracket bolted to the bottom plate and in another bolted beneath the side, and it has upon its extremity a loop D, to receive the iron-pointed lever. By means of the latter the cross shaft is turned and the

roller thrown in or out of gear, while it is retained in either position by a key upon the side of the slide which secures the shaft.

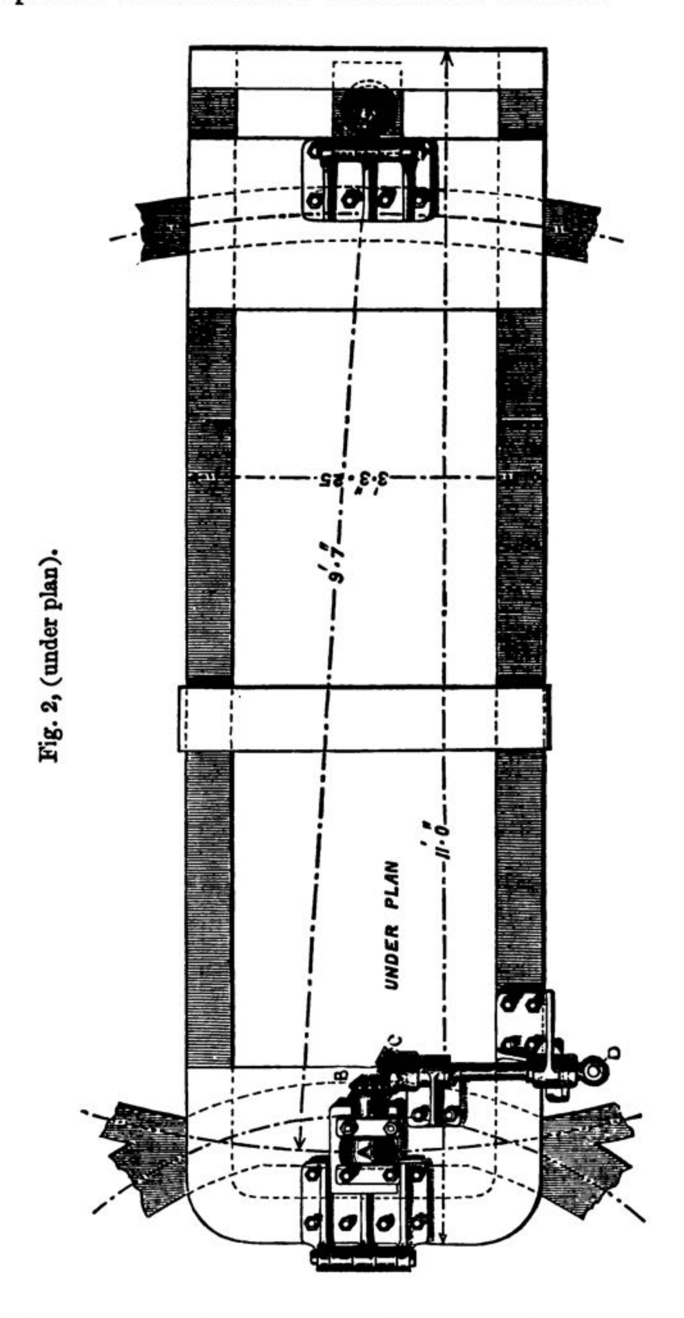


Fig. 2, (under plan).

7″ M.L.R. of $6\frac{1}{2}$ Tons Slide. Mark I. (Service Pattern.)

7″ M.L.R. of $6\frac{1}{2}$ tons slide, Mark 1. (*See* R.C.D. photolithograph, 81B.)

The slide consists of two sides, two transoms, two bottom and one top plate, a diagonal stay, a block, and four flanged feet with rollers.

The sides are bent round in the usual manner in front, and there united by a connecting plate upon the inside. They have a slope of $1\frac{1}{2}°$ in addition to 2° given by the deck.

The front transom connects the sides about 15″ from the head; it is formed of $\frac{7}{8}$″ plate with a piece of angle iron riveted along the upper edge.

The top plate is ¾″ thick, and is bolted over the head and front transom; it has a large slot in it to give access to the parts beneath.

The rear transom is of angle iron bolted to the rear extremities of the sides.

The front bottom plate is bolted beneath the sides about 10″ from the head, and is slotted to admit of a centre metal roller being placed when the slide is used as a "revolving" one. The other bottom plate is slightly bent down and secured by clips across the centre of the slide.

The centre of the diagonal stay rests upon and is bolted to the latter bottom plate and the extremities of its arms bolted to the girder sides.

The block consists of a frame of angle iron over which a piece of plate iron is riveted: it is bolted beneath the sides 14″ from their rear extremities.

The flanged feet for the rollers consist each of a fore and hind flange; the latter for the rear rollers are in the form of simple hooks, which catch over the axles of the rollers, those for the front rollers have holes in them to receive the axles in the usual way. The front flanged feet are bolted to and project from the sides, while those in rear are bolted to and project from the block. The rollers are of metal, conical in shape; the axles of the rear rollers are eccentric and each formed with a loop to receive the iron-pointed lever.*

The ends of the block and of the front bottom plate are shod with metal friction plates to take the bearing on the racers; the spaces between the block and its friction plates are filled in with wood to prevent injury to the block by the lodgement of salt water.

The slide is fitted in the usual manner for the Elswick compressor, and has also the following fitments; namely,

Stops for the carriage when run up and on recoil, similar to those on the 7″ platform.

Metal stops under the sides in front for the stop handspikes to bear against in traversing.

Sabicu foot planks resting on the block and on the diagonal stay.

A bollard, eyebolts, and winch gear as in the slide for the 7″ gun of 90 cwt.

Metal joints with flaps, one for housing inboard on the head of the slide, one for pivoting on the rear of the block.

Pivot plates with pivot heads for the attachment of pivot bars bolted upon the top plate.

A metal bracket bolted to the front bottom plate to receive the eccentric axle of a centre roller when the slide is used as a "revolving" one; upon the front of the bracket a small iron plate is fitted to prevent the axle from falling out in traversing; the axle† has a loop upon the extremity for the iron-pointed lever.

Axletree bands to receive a transporting axle bolted beneath the sides in front of the block.

8″ M.L.R. of 9 Tons Slide. Mark I. (Service Pattern.)

8″ M.L.R. of 9 tons slide, Mark I.

This slide is similar to that for the 7″ gun of 6½ tons, and like it fitted for the Elswick compressor, but the rear transom is of 1″ plate let into the sides and secured to them by knees, a third bottom plate is also added beneath this transom.

The slide is not fitted with winch gear, but instead with Captain Scott's gear for running in and out, training, and traversing.

---

* Mark I. axles had separate sockets affixed.

† Mark I. had a separate socket affixed.

The running in and out gear is as follows:—(See Fig. 1, which is that of a 9″ slide with two chains).

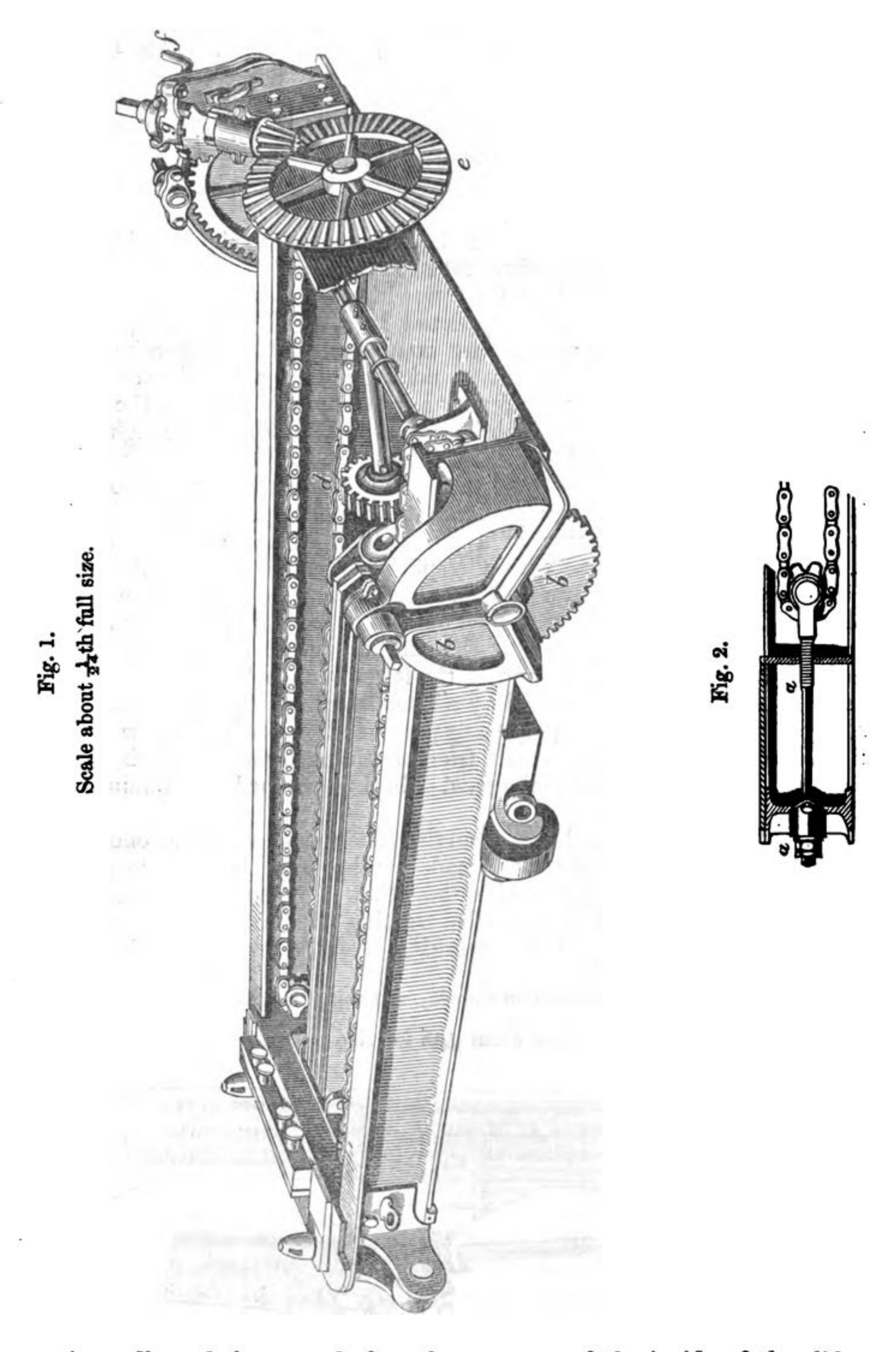


Fig. 1.
Scale about $\frac{1}{24}$th full size.

Fig. 2.

An endless chain extends from front to rear of the inside of the slide on the left, supported on chain wheels. The front chain wheel is pinned to an adjusting screw *a*, Fig. 2, by which its tension can be regulated, and the rear wheel keyed to a cross shaft. The adjusting screw passes through the head of the slide and the front transom, and is secured by

two nuts, a metal bearing or socket being bolted upon the front transom for it, in which are placed india-rubber rings separated by washers.

The cross shaft is made in two pieces coupled together by a cylinder and pins; it passes through the girder sides and is supported by two metal brackets bolted upon the rear bottom plate; it is worked by a winch handle, pinion and spur wheel *b*, Fig. 1, outside the slide on either side. The spur wheel and pinion are covered by a metal guard bolted to the slide, and in which the bearing for the spindle of the pinion is formed. Upon the inside of the spur wheel, cast in one with it, is a ratchet wheel in which a movable pawl, pivoted to a socket on the side of the slide, gears.

Two small metal brackets (not in fig.) are bolted to the metal guard, in which the winch handles when not in use can lie.

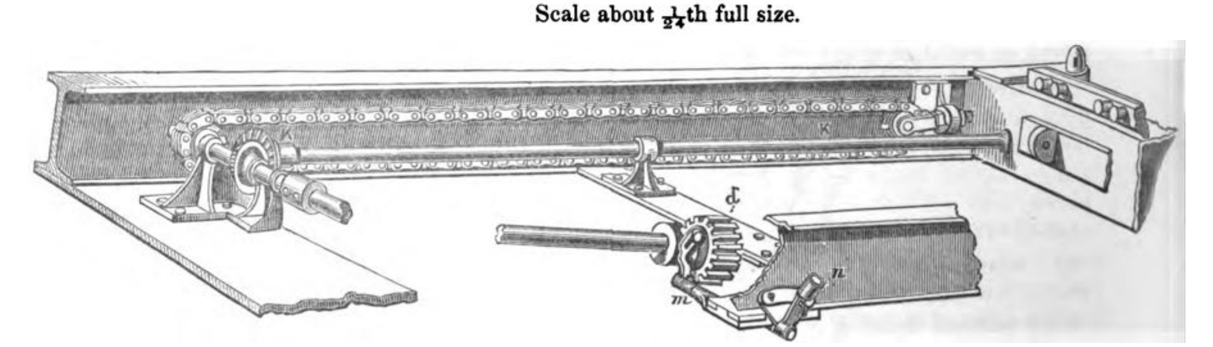
The training gear consists of the following:—

A short longitudinal shaft, supported in a metal bearing upon the block and in another upon the rear transom, has keyed upon its front extremity a metal pinion *d*, Fig. 1, which gears in a metal rack upon the deck, and upon its rear extremity a metal crown wheel *e*, the latter of which is set in motion by a pinion and winch handle at the right side of the slide. The spindle of the pinion is held in a metal bracket bolted upon the end of the side of the slide; an arrangement to pawl it, and so fix the slide to any point on the deck, or gradually control its motion, is added, consisting of a pawl wheel, pawl, and screw break. The pawl wheel is in one with the spindle of the pinion and the pawl is hinged to the bracket by a bolt with a collar and keep pin. The screw break is in the form of a small bow or cramp, pivoted by a screw in the centre on the metal bracket at the end of the slide, with the pawl wheel between its arms; on one of the latter is a small projecting piece and in the other a screw worked by a lever handle *f*, Fig. 1, attached by a fixed screw; under the projecting piece and under the screw lying upon the pawl wheel are small friction pieces, between which, when the lever handle is worked, the pawl wheel is jammed and retained as desired.

When the slide is fitted as a revolving slide, with a centre roller and traversing gear, an arrangement is made for throwing the training pinion out of gear with its rack while the slide is being traversed. The arrangement consists of having the training pinion to slide upon its shaft, as a clutch *d*, Fig. 3, and working it by a lever *m*, with crank

Fig. 3.—Section showing traversing shaft.

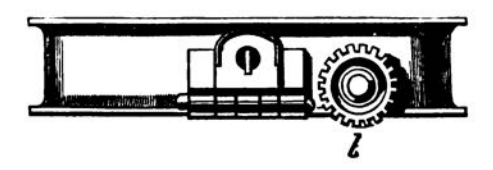
Scale about $\frac{1}{24}$th full size.



held in a metal bearing under the right side of the slide, and having upon its outer extremity a socket *n*, in which the iron-pointed lever fits to move it by; a pin is added to secure the socket in any desired position, *i.e.*, with the training pinion in or out of gear.

The traversing gear is combined with the running in and out gear so that the same winches work both; it consists of a long longitudinal shaft extending along the left of the slide and passing out through the head, supported in metal brackets. Upon the front extremity of the shaft, outside the slide, a traversing pinion *l*, Fig. 4, is fitted, and upon the other extremity a bevel wheel *k*, Fig. 3, into which a

Fig. 4.—End view of slide, showing traversing pinion.



bevel pinion keyed upon the cross shaft of the running in and out gear works.

When it is required to traverse, the traversing pinion is placed upon its shaft and the training pinion thrown out of gear; the traversing shaft is then worked as desired, by the winches of the running in and out gear (the chains of course detached from the carriage). When the traversing is completed, the traversing pinion is removed and the training pinion thrown into gear again.

9″ M.L.R. of 12 Tons Slide, Mark I. (Service Pattern.)

9″ M.L.R. of 12 tons slide, Mark I.

This slide is similar to the preceding, and fitted like it for the Elswick compressor and also with Captain Scott's running in and out and training gear, but the running in and out gear has two endless chains, one on each side of the slide. (See Fig., page 199.)

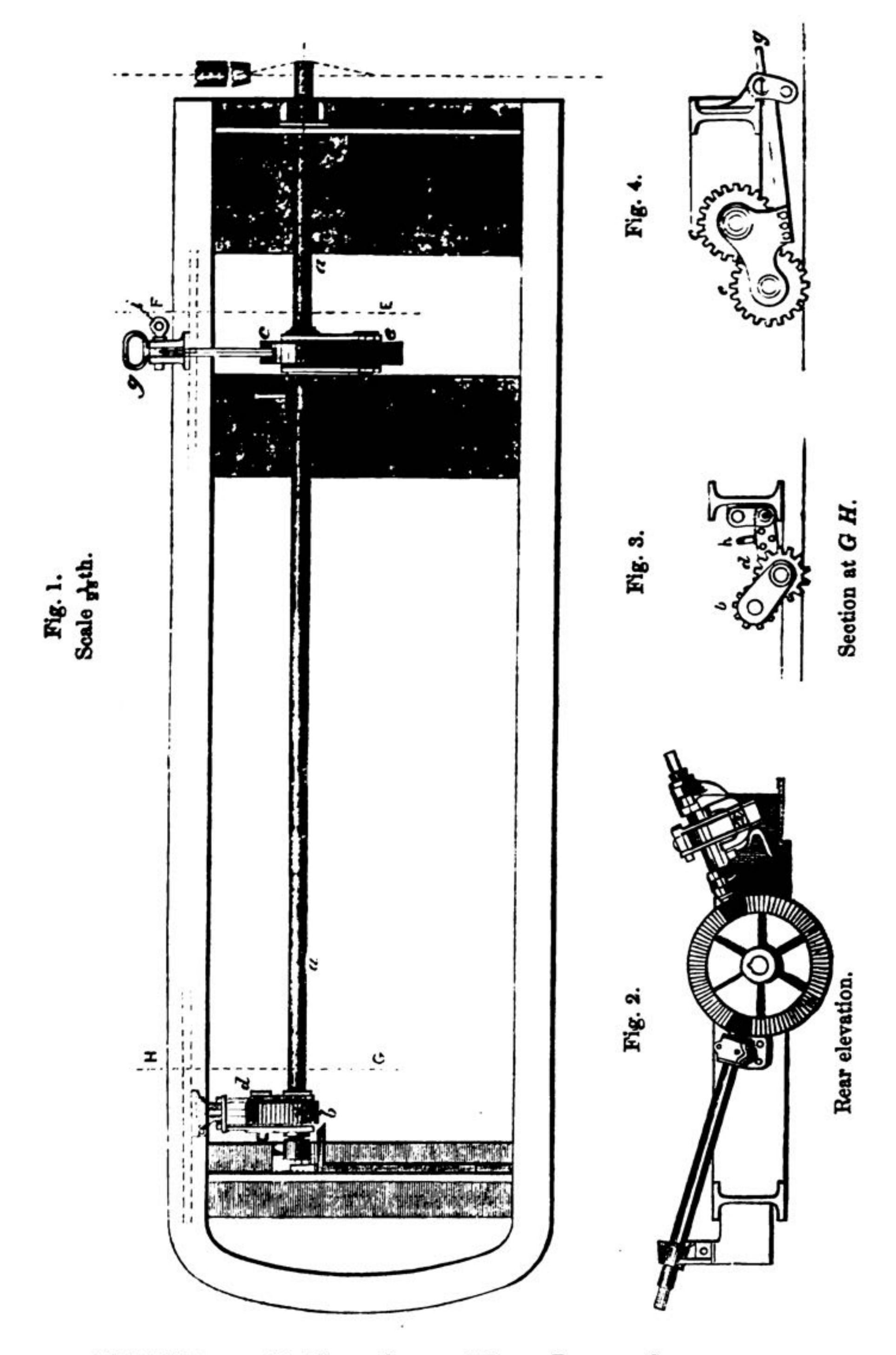
Revolving 9″ slides fitted, that is, for traversing as well as training, have a different arrangement of traversing and training gear to that described for the 8″ slide. It is as follows:—*

A long shaft *a*, Fig. 1, page 202, extending the length of the slide from the front transom, takes the place of the short traversing shaft, being worked in the same manner as the latter, but with the addition of a second pinion and winch handle on the left, similar to that on the right, but of necessity with a longer spindle. Upon the long shaft two pinions are keyed, one *b*, just behind the front bottom plate, and the other *c*, just behind the rear block, the former gearing in a traversing pinion *d*, and the latter in a training pinion *e*.

As these pinions must not both be in gear with their racks on the deck at the same time, each is held in a bracket which is pivoted on the shaft, and can be raised or lowered as required, thereby lifting the pinion out of or lowering it into its rack. The bracket of the training pinion has a lever *g* projecting to the side of the slide, with a handle at the end for moving it by, while the bracket of the traversing pinion has merely a handle *h*. The lever of the training pinion bracket is secured in any required position by a keep pin *i*, outside the right side of the slide, and the bracket of the traversing pinion by a keep pin *l* inside the same slide.

---

* As issued to the "Lord Clyde."



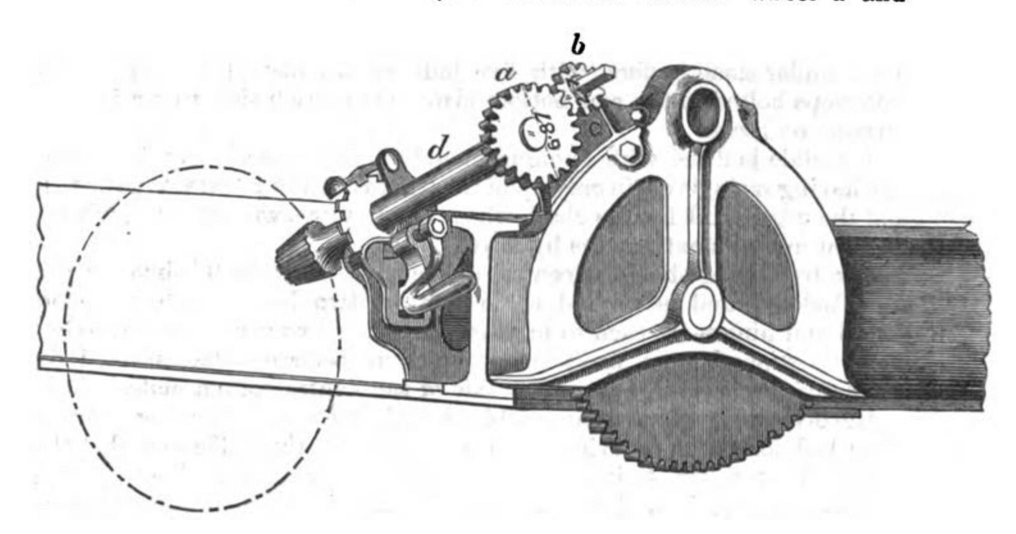
9″ M.L.R. of 12 Tons Slide, Mark I., for Ships of the "Audacious" Class.

9″ M.L.R. of 12 tons slide, Mark I., for "Audacious."

This slide is the service pattern just described, with the roller flanges placed immediately under the sides, the latter being slightly recessed to admit the rollers. The rear rollers are hollow-soled or grooved to run upon ribs on the racer, in order to assist the pivot and pivot bars; they

are not eccentric, and are secured in their flanged feet in the same manner as the front rollers. A tie bar is also added across the slide from one axle to the other of these rollers.

The training shaft lies central in the slide, and is worked by a pinion and winch handle at each side, an additional toothed wheel *a* and



pinion *b* being introduced to increase the gain of power, the former on the end of the spindle of the pinion, and the latter in a bracket upon the guard over the running in and out spur wheel. The brake arrangement is fitted in a bracket bolted to the rear transom instead of on the end of the slide.

The securing flap is hinged to a joint bolted to the rear bottom plate to the right of the centre line.

A holding-down hook, for the purpose of securing the slide in a seaway and also assisting the pivot in recoil, is bolted to the bottom plate; it catches under the strong projecting lip of a racer secured to the deck for the purpose.

9″ M.L.R. of 12 Tons Slide, Mark I. (Scott's Pattern), Special for Ships of the "Sultan" Class.

9″ M.L.R. of 12 tons slide, Mark I., for "Sultan." (See R.C.D. photolithograph, 87.)

As mentioned in the description of Scott's pattern carriage, the chief feature of this slide, as compared to the service pattern slide, is its height.

The slide is formed of two girder sides, 10″ deep by 5″ wide in the flange, as in the service pattern, bent round in front in the same manner, and there secured together by a connecting plate on the inside, and by the bracket for the bolt of the pivot bars outside. The transom between the rear ends of the sides is of plate riveted to an angle-iron frame, and the sides are further united by three bottom plates, one under the head, one under the transom, and one about 3′ from the rear end of the slide.

The flanged feet for the front rollers are each in one piece, bolted under the bottom plate, so as to bring the rollers under the sides. The flanged feet for the rear rollers are made in two parts, the front flange of each bolted to the centre bottom plate, and the rear flange directly to the side. The rollers are similar to those for the 9″ service pattern slide for the "Audacious," namely, the rear not eccentric and grooved to run on a ribbed racer.

Instead of being fitted for the Elswick compressor the slide is fitted for the bow compressor, by having two tapered plates 7″ deep secured by

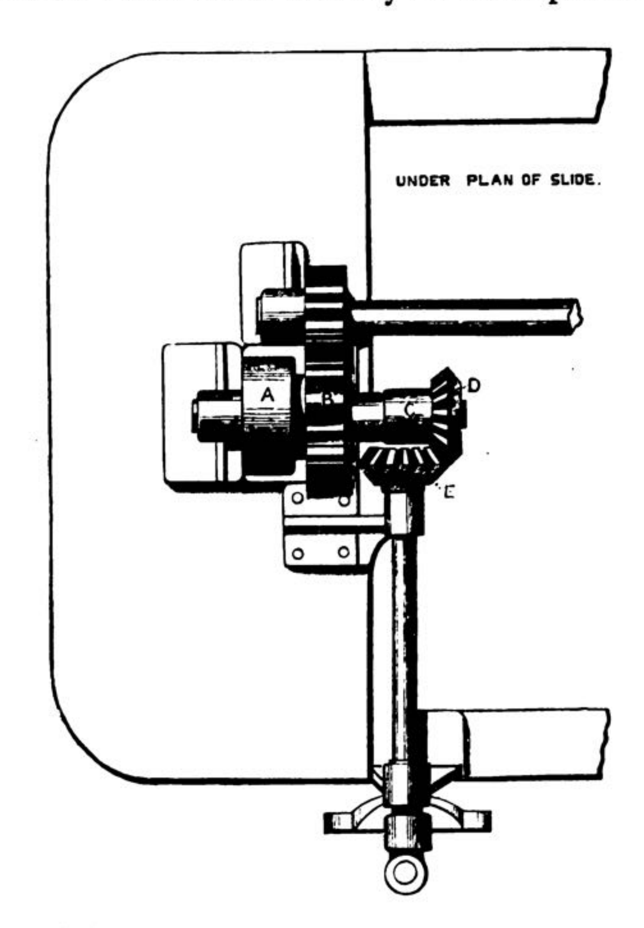
keep pins on gudgeons, which are bolted to the outer side of each girder side, and by having the space between the flanges of each girder side, both inside and outside, for the length of the plates, filled in with sabicu, secured by screws.

Upon the inside of the head of the slide a buffer plate is bolted, to which a wooden buffer block, with four plates of india-rubber intervening, is attached by two bolts to receive the carriage when run up. Two similar small buffers (with five india-rubber plates) are attached to iron stops bolted to the rear bottom plate, one at each side, to receive the carriage on recoil.

The slide is fitted with running in and out gear, as already described, but having a single chain only upon the left (as in the 8″ service pattern), and the cross shaft for the chain wheel in one piece, with the spur wheels secured upon its extremities by keys.

The traversing shaft lies central in the slide, as in the 9″ slide for the "Audacious," and is worked, as in that, by two levers, with a second wheel and pinion for each to increase the gain of power. The traversing shaft is supported in front in a semicircular-shaped plate riveted by means of angle iron to the under side of the centre bottom plate.

Revolving slides have the combined training and traversing gear, as described for the 9″ service pattern slide, with the difference that the centre front roller A is connected with the traversing pinion B, and both are thrown in and out of action by the same operation. This is



effected by placing the connected roller and pinion on an eccentric axle C, having a mitre pinion D on its rear extremity. In this pinion

another mitre pinion E on the end of a short cross shaft, which projects at the side of the slide, gears, while on the projecting end of the shaft there is a socket to take the iron-pointed lever. As the shaft is turned it raises or lowers the roller and traversing pinion, and the latter are secured either in or out of gear by pinning the shaft to a small bracket outside the side of the slide.

A holding-down hook, similar to that on the 9″ slide for the "Audacious," but not rigidly bolted to the slide, is fitted upon the head of the slide; it is retained when in action by means of a bolt. A sabicu foot plank is fixed down the centre of the slide.

Revolving slides of the "Sultan" pattern have been supplied to the "Blonde" and "Raleigh," but with the peculiarity that they are fitted to traverse on small turntables. A solid beam of iron, 3″ thick by 10″ wide, is bolted beneath the girder sides near the centre, to which is fixed a differential hydraulic jack (Tangye's) worked by a lever at the side of the slide. On the turntable, beneath the ram of the jack, there is a socket for the ram to enter. When the jack is worked, and the ram made to bear in the socket, the traversing pinion is relieved of the weight of the slide, and the latter, the turntable moving with it, is then moved as required by the traversing gear. When the slide is in its new position the jack is again worked to take the weight off the ram, and to withdraw the latter from the socket on the turntable.

Instead of having one central foot plank these slides are fitted with two, one along each side; they have also the axles of the rear rollers secured by metal clips.

10″ M.L.R. of 18 Tons Slide, Mark I. (Scott's Pattern), for Ships of the "Sultan" Class.

10″ M.L.R. of 18 tons slide, Mark I., for "Sultan." (*See* R.C.D. photolithographs, 88 and 88a.)

This slide is similar in construction to the 9″ slide for the "Sultan," and fitted like it for the bow compressor. The girder sides are $11\frac{3}{4}$″ deep by $5\frac{1}{2}$″ wide in the flange, and are connected by a front transom and top plate in addition to the three bottom plates and rear transom, and the front as well as the rear rollers are grooved.

The front buffer to receive the carriage when run up is similar to the front buffer of the 9″ slide, but with six india-rubber plates; it is attached to the front transom. The rear buffer is also of similar form, with eight plates, and is attached to a stay of plate iron bolted to the rear bottom plate by means of angle iron, and to a top plate which lies over and is bolted to the rear transom. An iron stop is also bolted to each girder side to receive the carriage when the rear buffer has been compressed 4″.

A side step is bolted, on each side of the slide, to iron brackets for the purpose, and a folding step is placed at the rear of the slide attached to two brackets bolted to and projecting from the rear bottom plate.

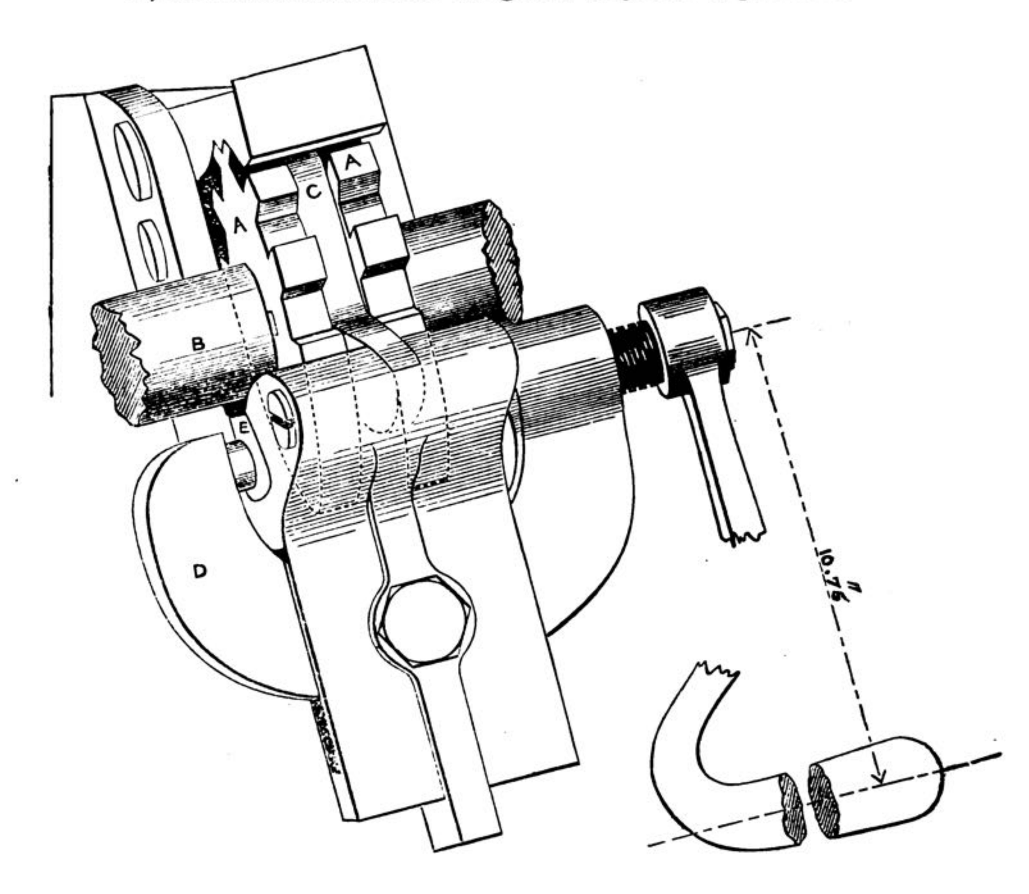
The slide is fitted with running in and out and training gear similar to that of the 9″ slide, "Sultan" pattern, but the running in and out gear has two chains, &c., and the crown wheel of the training gear is of cast iron instead of metal; the latter gear is also without the additional wheel and pinion for gain of power. The semicircular plate forming the front bearing of the training shaft is bolted to the girder sides a little in front of the second bottom plate.

Revolving slides of this pattern for the "Sultan" are not fitted with traversing gear, but are traversed on small turntables in a somewhat similar manner to the 9″ revolving slides. A built-up iron beam is fixed across the slide beneath the sides, to which the hydraulic jack is attached, in such a position that when the gun is run in and the pump

worked the front end of the slide is raised off the deck, and the whole weight borne on the turntable, which is then traversed by means of winches, as desired.

10″ slides of the "Sultan" pattern have also been made for the "Hercules," but 3″ less in height, which involves a difference in the depth of the roller flanges in the shape of the holding-down hook, and in the depth of the front bearing plate of the training shaft.

It is intended to issue to ships of the "Temeraire" class slides the same as those of the "Hercules," but with the radii of the racers reduced to 5′ 11½″ in front and to 15′ 2½″ in rear, also with the brake gear modified, so as to double the frictional resistance as follows:—The brake wheel is divided into two discs A, A, with feathers to allow of their sliding upon the pinion shaft B. Between the discs a circular friction plate C is attached to the supporting bracket of the shaft; against this the discs are pressed by the cramp D and friction segments E, four frictional surfaces being thus subjected to pressure.



10″ M.L.R. of 18 Tons Slide. Mark I. (Scott's Pattern), for Gunboats of "Snake" Class.

10″ M.L.R. of 18 tons slide, Mark I., for gunboats. (*See* R.C.D. photolithograph, 88B.)

This slide is the same in the construction of the frame as the 10″ "Sultan" pattern, and fitted for the bow compressor. It has no rollers, but the sides are supported at the required slope of 3½° by two forged iron stays or brackets under each, each stay of one side being connected with the corresponding stay of the other side by a tie bar. Beneath the head of the slide and beneath the stays metal friction plates are secured to take the bearing on the racers.

The slide is pivoted near the front immediately under the centre of gravity of the system when the carriage is run up, a pivot plate for the purpose being bolted across beneath the sides.

A folding step is attached to the slide in rear, but there are no side steps.

For the breeching rope to bear against a wood cushion is fitted round the head of the slide, and at each side a metal loop is bolted over it, through which the rope passes to the carriage.

Upon the head of the slide a loading derrick is pivoted, a plate for the purpose, on each side, being secured to the cushion and the girder side.

The slide is not fitted with running in and out, training, or traversing gear, but for running the carriage in two metal sheaves are pivoted in a metal bracket bolted on the rear bottom plate ; through these sheaves and through two corresponding ones on the carriage a fall is rove and worked by a steam winch. On each side of the metal bracket a bollard with hook is fixed.

A fixed iron securing flap is attached to the connecting bar of the rear side stays.

11″ or 12″ M.L.R. of 25 Tons Slide. Mark I. (Scott's Pattern), for the "Hotspur."*

12″ M.L.R. of 25 tons slide, Mark I., for "Hotspur."

This slide is very similar to the 10″ slide for the "Sultan," and fitted like it for the bow compressor, but with the compressor bars on the inside of each side.

The girder sides are 18″ deep by $7\frac{3}{4}$″ wide in the flange ; attached to the rear of the slide are two steps, one above the other, and down the centre a broad foot plank is placed, while over the rear rollers iron guards are fixed.

The slide is fitted with running in and out and with training gear. In the running in and out gear the spur wheels with their driving pinions are placed upon the inner sides of the girders, the latter passing through and supported in metal bearings in the webs ; the spur wheels are not upon the shaft of the chain wheels, but each upon a spindle of its own to the front of the latter, and upon each spindle there is a pinion gearing into a spur wheel upon the chain wheel shaft. This arrangement increases the gain of power as compared to the arrangement in the 10″ slide. Upon the outer end of each spur wheel spindle outside the girder side the ratchet wheel is fixed, into which a pawl, pivoted to the front, drops.

In the training gear, in order to increase the gain of power, the crown wheel (of metal) is not placed on the training shaft, but upon a spindle above it, while a pinion upon the spindle gears into a bevel wheel (of metal) upon the end of the shaft.

In addition to the brake on the traversing gear a special brake is added for nipping the rear racer. It consists of two cramps with friction pieces to nip the racer, one loosely pivoted in a metal bracket bolted to the bottom plate immediately inside the flanged foot of the roller; through the end of the rear arm of each cramp a screw, worked by a lever arm, acts upon the friction pieces and racer in the same manner as the cramp screw in the pawl wheel of the training gear. The lever arms of both cramps are connected by a bar which has projecting upwards from it an arm carrying a metal nut ; through the nut a screw

* Similar slides, but of less height (to reduce the height of the axis of the gun to 4′ 1″), and with the brake modified, are to be made for ships of the "Temeraire" class.



passes, which being turned causes the nut to travel, so moving the connecting bar and acting upon the cramps. The screw is moved by a short shaft, with hand wheel, placed parallel to the longitudinal axis of the slide, and held in a metal bearing on the lower rear step, and in another on the bottom plate, the shaft and screw having each a mitre pinion, one gearing into the other.

SLIDES IN TURRETS.

Slides in turrets.

The slides for turret carriages are fixtures or parts of the turret; the sides are formed of two upright plates with a piece of tee iron riveted between them at top, the flange of which forms the bearing surface of the carriage, and at bottom they are connected to the deck by angle iron.

CHAPTER IV.—BOAT CARRIAGES AND SLIDES.

The following are the carriages and slides for boat service,* namely:—

Table.

Nature.	Weight.			Tonnage.
	cwts.	qrs.	lbs.	tons.
9-pr. B.L.R., Mark II., top carriage - - -	3	1	0	—
" " under " - -	1	2	0	—
" " slide " - -	3	0	0	—
12-pr. B.L.R., Mark II., top carriage - -	3	1	0	—
" " under " - -	1	2	0	—
" " slide " - - -	3	0	0	—
9-pr. B.L.R., Mark III., carriage - - - -	2	3	8	} ·843
" " slide, with buffer - -	4	0	0	
†12-pr. B.L.R., Mark III., carriage - - -	2	3	6	·345
" " slide, with buffer - -	4	0	18	·302
7-pr. M.L.R., bronze, of 200 lbs., Mark I. carriage -	1	1	20	·082
" " " slide, with buffer	2	0	21	·230
7-pr. M.L.R., steel, of 200 lbs., Mark I. carriage - -	1	0	21	·0768
" " " slide, with buffer	2	1	1[illegible]	·257

† This carriage will take the 9-pr. M.L.R. gun of 8 cwt. when fitted with the same elevating screw as that of the 9-pr. M.L.R. field marine carriage (converted), placed 1½" more to the rear than the old screw. It will also take the 9-pr. M.L.R. of 6 cwt., with a screw 6" shorter than for the 8-cwt. gun, and placed 4½" to the front of the old screw.

9-PR. B.L.R. MARK III. CARRIAGE AND SLIDE.

9-pr. B.L.R., Mark III., carriage and slide. (Similar to 12-pr., which *see*, R.C.D. photolithograph, 91B.)

The 9-pr. carriage is a small wooden sliding carriage with common cross-handled elevating screw, stool bed and quoins, without rollers, and fitted for the hydraulic buffer. It has front and rear outside holding-down clips, and at the extremities of the brackets stop plates to meet stops upon the platform in recoil and in running up.

The slide is of wood, without rollers, but fitted with friction plates, having a supporting block hinged by keys and secured by hooks under the rear, and in the front transom a hole for a fighting bolt, by which it is pivoted. In section the sides are wider at the top than the bottom, in order to form on each a projection, under which the clips of the carriage can catch. A bearing plate for the cap of the buffer to rest against is bolted between the rear extremities of the sides; iron stops

* The ·45 Gatling gun, without its carriage (ship), will probably also be used as a boat gun.



for the carriage are fixed upon the top surfaces of the sides in front and rear, and bands for a transporting axle under the sides towards the front.

The buffer lies upon the centre and rear transoms, to each of which it is secured by a band, the ends of which pass through the transom and are nutted beneath. The buffer itself is similar to the land service buffer, but much smaller, and the front end closed by a cap instead of by a flange and cover, into the side of which the tap screws, a patch being added to give sufficient thickness for it to screw into. The internal diameter of the cylinder is 4·05″, the diameter of the piston rod 1·5″, the diameter of the holes (four) in the piston ·675″, and the length of the cylinder and rod such as to admit of a recoil of 2′ 11¼″. For use it is filled with 6 quarts of oil.

9-pr. B.L.R., Mark II., carriage and slide.

The 9-pr. B.L.R., Mark II. carriage, A, Figs. 1 and 2, and slide D, Fig. 1, differed from the preceding in being fitted for the Elswick compressor instead of the buffer, in the slide not being fitted with axletree bands, and also in having the addition of an "under" carriage, upon which the carriage proper could be mounted on board ship for firing through a port. The compressor consisted of two clip plates, *d*,*d*, Fig. 3,

Fig. 1.

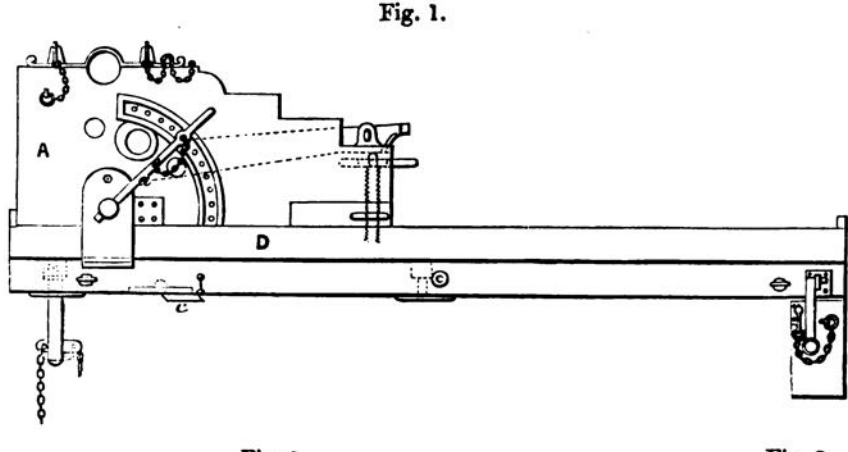
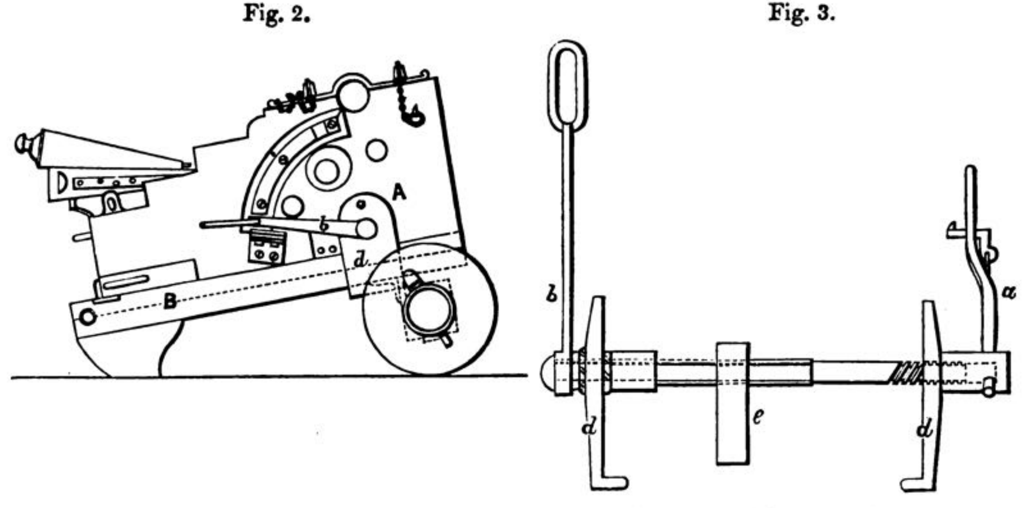


Fig. 2. Fig. 3.



suspended upon the outside of the brackets, a shaft with a left-handed thread cut on one end, and a right-handed thread upon the other, passing through them. Outside each plate on the shaft was placed a nut worked by a lever, that on the left, *a*, Fig. 3, being used as an

adjusting lever, and that upon the right (*b*) as a compressing lever. The adjusting lever, being keyed, throwing down the compressing lever squeezed the nuts against the plates and the latter against the slide. The compressor was made self-acting by a lever *e*, Fig. 3, being placed upon the centre of the shaft, which caught against a tripper pivoted between the sides of the slide. The under carriage B, Fig. 2, was formed of two parallel pieces of oak bolted to an axletree with two wooden trucks in front and to a block in rear, so as to stand at an incline to the rear; the upper carriage was secured to it by two studs projecting from a bar of angle iron across the under carriage, which entered sockets in the rear block of the upper and by the clip plates of the compressor.

12-pr. B.L.R. Mark III. Carriage and Slide.

12-pr. B.L.R., Mark III., carriage and slide. (*See* R.C.D. photolithograph, 91B.)

This carriage and slide is similar to the 9-pr. Mark III., but the diameter of the holes in the piston of the buffer is ·625″, and the length of the cylinder and rod such as to admit of a recoil of 3′ 2½″. For use it is filled with 6 quarts of oil.

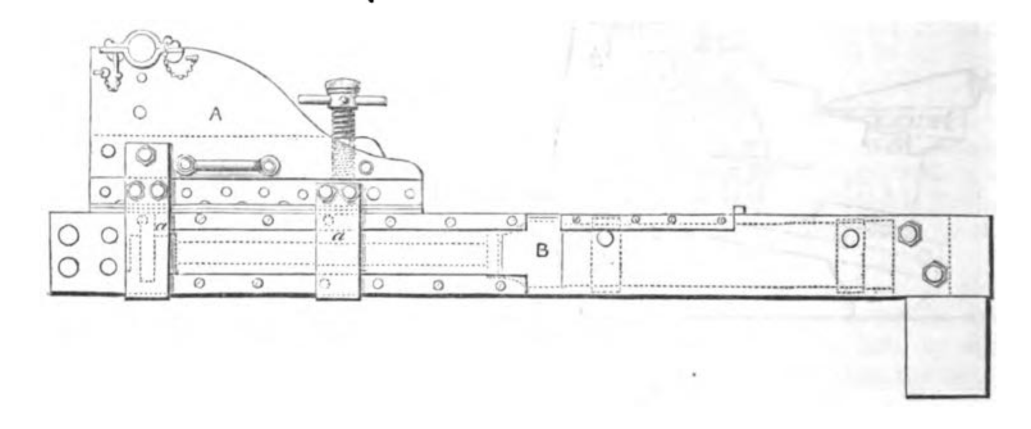
*7-pr. M.L.R. Bronze Gun of 200 lbs. Mark I. Carriage and Slide.

7-pr. M.L.R. bronze gun of 200 lbs., carriage and slide. Mark I.

The carriage A is formed of two brackets of plate iron riveted to a bottom plate by means of angle iron on the outer sides, and bolted to a wooden bed between them. It is fitted with the common cross-handled elevating screw, two outside holding-down clips at each side, a lifting handle on each bracket, and with a bracket underneath the bottom plate for the attachment of the buffer.

The slide B is formed of two wood sides connected by an iron plate with a hole in it for a fighting bolt in front, and by a wooden transom and supporting block in rear. It is fitted with stops for the carriage upon the top surfaces of the sides in front and rear, with two iron bands between the sides for the buffer to rest in, and two securing screws to hold the latter, the end of which abuts against the transom.

The buffer is the same as that for the 9 or 12-pr., but the holes in the piston are ·75″ in diameter, and the length of the cylinder and rod



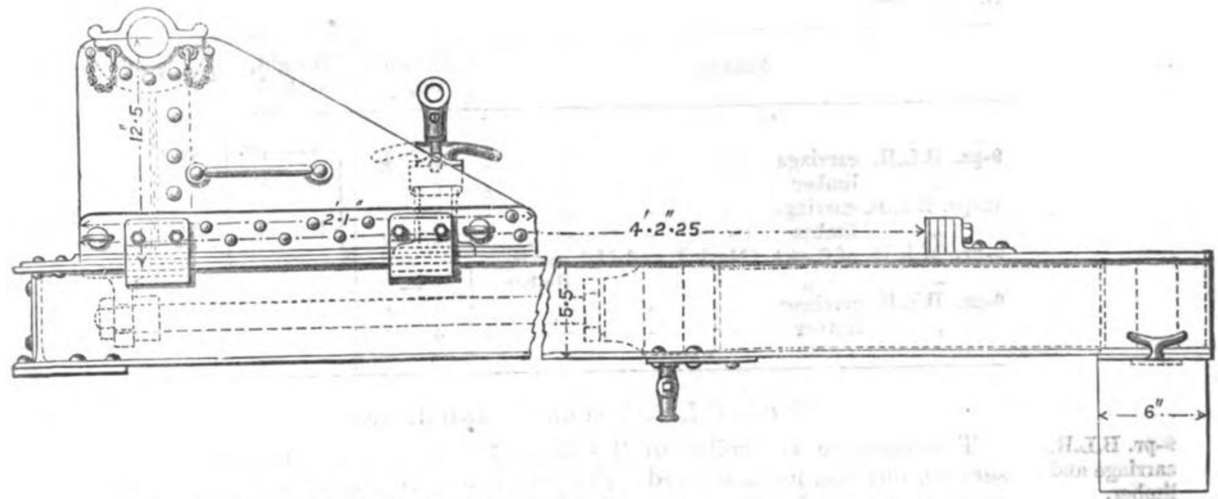
is such as to admit of 1′ 11″ recoil. It weighs 2 qrs. 6 lbs., and for use is filled with 7 pints of oil.

* The 7-pr. steel, 200 lbs., will not fit on this carriage; that of 150 lbs. will.

7-pr. M.L.R. Steel Gun of 200 lbs., Mark I. Carriage* and Slide.

7-pr. M.L.R. steel gun of 200 lbs., carriage and slide.

The carriage consists of two brackets of $\frac{1}{4}''$ plate riveted to a bottom plate by means of angle iron on the outer sides, and connected in front



by a transom of plate riveted to angle iron, and in rear by another transom, if it may be so called, of angle iron.

It is fitted like the preceding carriage with two outside clips on each side, with a handle on each bracket, and with a "tumbler" elevating screw, the nut of which oscillates in a metal pedestal bolted upon the bottom plate.

The slide consists of two sides of girder iron $5\frac{1}{2}''$ deep, bent round in front and jointed by a connecting plate, three bottom plates, and a rear transom: the latter has a wooden block placed in front of it between the sides for the buffer to bear against. In the front bottom plate there is a hole for the fighting bolt, and upon the upper surfaces of the side stops are fixed for the carriage, the rear stops having india-rubber plates attached to them.

The buffer is secured by bands upon the rear and centre bottom plates, nutted beneath them; upon the outside of the right side of the slide a staple to hold a spanner for the buffer is attached. The buffer itself is the same as for the 7-pr. bronze gun, but the holes in the piston are ·65", the cylinder is 28" long, and the recoil allowed is $25\frac{1}{4}''$; it is filled with 4 quarts of oil.

---

* This carriage will also take the 224 lbs. bronze 7-pr.

CHAPTER V.—TRAVELLING CARRIAGES.

The following * are the travelling or "field marine" carriages, namely :—

Nature.	Weight, empty.		Weight, packed.		Tonnage.
	cwts.	qrs.	cwts.	qrs.	tons.
9-pr. B.L.R. carriage	6	3	17	0	2·75
" limber	6	0			
12-pr. B.L.R. carriage	7	3	18	2	3·21
" limber	6	0			
9-pr. M L.R. of 8 cwt. (Mark I. and II.) carriage	—		—		—
" " " limber	—		—		—
6-pr. B.L.R. carriage	4	4	—		—
" limber	4	4	—		—

9-pr. B.L.R. Carriage and Limber.

9-pr. B.L.R. carriage and limber.

The carriage is similar to the 6-pr. B.L.R. gun carriage for land service, but smaller, and fitted with a "common cross-handled" elevating screw and special axletree and wheels, the latter 3′ 6″ in diameter, with metal pipe box and ring tire 3″ wide, and rounded off at the edges; the track of the wheels is 3′ 6½″. The carriage has no axletree boxes proper, but a small box opening next the wheel is attached to the left bracket over the axletree bed.

The limber consists of a light frame bolted over an axletree bed and fitted with single reversible shafts (with two slats), and with a pole (with two slats) for man draught. Its axletree and wheels are the same as those of the gun carriage, and both it and the gun carriage are painted black. It carries two long side boxes to contain 12 rounds each, which open next the wheel, and two centre boxes.

12-pr. B.L.R. Carriage and Limber.

12-pr. B.L.R. carriage and limber.

The 12-pr. carriage is similar to that of the 9-pr.; it is fitted with an iron stoolbed hooked to staples on the trail and resting upon the elevating screw in rear to adapt it for carrying the 12-pr. S.B. howitzer.

The limber is the same as that used with the 9-pr.

9-pr. M.L.R. Carriage.

9-pr. M.L.R. carriage.

This carriage is converted from the preceding by substituting for the common cross-handled screw, one similar to that in use with the 9-pr. M.L.R. carriage for land service, but shorter and working in a cross-handled nut with two gudgeons, which oscillate in metal bearings. Some of the minor fittings are also removed and the position of others altered, see L. of C. § 2481. The carriage will also take the 9-pr. of 6 cwt., but with shorter elevating screw and differently placed.

* The ·45 Gatling carriage (ship) is also used as a travelling carriage with a limber carrying one box to contain six drums. The limber is of iron with the same wheels and track as its gun carriage, and is fitted with shafts and pole similar to those of the 6-pr. B.L.R. limber: weight about 5½ cwt. The ·65 Gatling carriage is to be used in the same way, with a similar limber to that for the ·45 carriage, but of different size in the frame and the box containing four drums.

6-pr. B.L.R. Carriage and Limber

The 6-pr. carriage and limber are similar to those for the 9-pr. or 12-pr., but the carriage is fitted with axletree boxes, and the limber carries one double centre box instead of two : the track of the carriage and limber is 3′ 9½″ instead of 3′ 6½″.

6-pr. B.L.R. carriage and limber.

CHAPTER VI.—MISCELLANEOUS.*

Cartridge cases for S.S. are the same as for L.S., except that the leather cases are painted in different colours, according to the deck upon which they are used, and those for rifled guns have a seizing at the centre of the handle, in order that they may be distinguishable by night from those for smooth-bore guns : also, for S. S. the 7″, 8,″ and 9″ M.L.R. cases (as well as higher natures) are made of Clarkson's material. They are as follows;—

Cartridge cases.

7″ M.L.R.	(A.)	weight,	5½ lbs.
8″ „	(B.)	„	6½ „
9″ „	(C.)	„	7½ „

Cleaning rods, though discontinued for L.S., are still used with B.L.R. guns for S.S. The stave of a cleaning rod is of ash, and the head of elm, studded with iron pins, round which hemp is wound.

Cleaning rods.

Dismounting chocks are used with wooden slides for dismounting a carriage from or mounting it upon its slide. A pair consists of two inclined planes of elm fitted with connecting bars and loops ; for use they are attached to the rear of the slide.

Dismounting chocks.

Stop handspikes are of ash, 4′ long, each fitted with a metal stop let into and riveted in the end. They are used in traversing a slide to stop the motion of the latter when required, the metal stop fitting into a plate upon the deck.

Handspikes, stop.

Lifting joint levers are used for raising the pivot flaps of revolving slides, and are of two descriptions, viz., "common," for use with wooden slides, and "S-shaped," for use with iron slides. For B.L.R. guns the end of the lever serves as the tin cup extractor.

Levers, lifting joint.

The boat magazine is a small wooden box fitted with grummet handles, the lid covered with leather and secured by a spring lock. The interior of the lid is fitted with leather loops ; a leather copper-bound case to hold cartridges and a leather case for tubes are carried in the magazine.

Magazine, boat.

Man harness, light, Mark II. for S.S., consists of two drag ropes of 2½″ white rope, each 18′ long and furnished with eight leather-covered hooks, to which web loops to go over men's shoulders are hooked ; the set of harness is completed by a web shoulder strap with a short piece of rope at each end, for supporting the shafts.

Man harness.

Side arms for S.S. are the same as for L.S., except that a rope stave is used with the 7″ M.L.R. guns, having a rammer head at one end and sponge head at the other ; and rope staves are also used for S.B. guns, with hanging ports. The 8″ M.L.R. gun takes the same wadhook as the 7″ or 9″, and the 7″ M.L.R. the same as the 68-pr. S.B. The

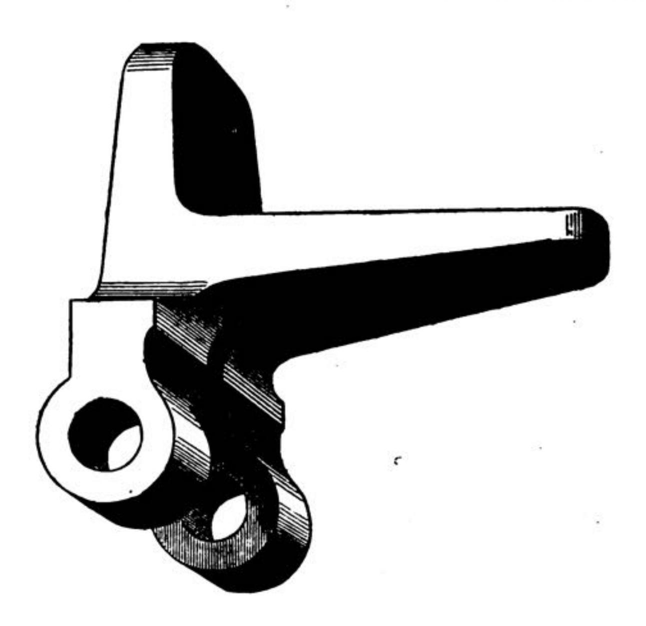
Side arms.

---

* *See also* Part II., Garrison Service.

length of the 8″ sponge is 11′ 1″, and its weight 15 lbs.; and the length of the 7″, 10′ 6″, and its weight 10 lbs. The mark on the rammer stave of the 8″ gun is 6′ 8″ from the face of the head, and that on the 7″ gun stave 6′ 8¼″. The 7″ M.L.R. of 90 cwt. has the same side arms as the 7″ M.L.R. of 6½ tons.

Transporting arrangements. For transporting a wooden slide on board ship an axle of round iron 3″ in diameter and weighing 1 cwt. is passed through the axletree bands under the rear of the slide and fitted with wood trucks: the metal flap on the front of the slide is removed and replaced by a transporting



bracket (see Fig.) which furnishes a bearing for the roller (wooden) handspike, the nib of which fits into the recess in its arm.

A wooden sliding carriage is transported upon its slide, though it may be transported by itself, as it has a hole in the front block to take the axletree, and a handspike iron on the rear block.

Iron slides are transported in a similar manner to the wooden slides, but the axles are square in section; they are each with four linch-pins, two washers, and four ties, as follows:—

Nature.	Section.	Weight.		
	in.	cwts.	qrs.	lbs.
7″ M.L.R. of 6½ tons, Mark III. - - -	3 square.	1	1	15
8″ M.L.R. of 9 tons or 9″ M.L.R. of 12 tons, Mark III.	4 „	2	3	20

The 7″ and 8″, or 9″ axles take metal-bouched trucks 8″ in thickness; Mark II. trucks are used with the latter, Mark I. with the former, the difference between them being in the size of the bouche. (Mark II., 8″ and 9″ axles were 3″ square). The axles are sufficiently strong to transport the carriage, with gun mounted, in each case.

Transporting carriage. For transporting guns of 6½, 9, and 12 tons on board ship there is a transporting carriage; it consists of two wood bolsters or axletree beds connected by three iron tie bars with an axletree let into each bed and fitted with wooden metal-bouched trucks 8″ in thickness.

For transporting heavy elongated projectiles on board ship there are three natures of barrows or trucks, one for projectiles under 10″, one for 10″, and one for 12″ projectiles (except case shot). The first-mentioned truck is formed of a frame of ash with iron guard in front, the projectiles being carried across, and two metal trucks. The two latter are similar and carry the projectiles longitudinally ; they are made of wrought iron and fitted with four metal trucks.

Trucks or barrows.

Barrow for 10″ projectiles.

Scale about $\frac{1}{28}$th.



INDEX.

LONDON:
Printed by GEORGE E. EYRE and WILLIAM SPOTTISWOODE,
Printers to the Queen's most Excellent Majesty.
For Her Majesty's Stationery Office.
[4800.—150.—8/74.]

ARMY EQUIPMENT.

Prepared at the Topographical and Statistical Department, War Office,
MAJOR GENERAL SIR HENRY JAMES, R.E., F.R.S., &c., *Director.*

Part IV.—MILITARY TRAIN.
Compiled by LIEUT. H. M. HOZIER, 2nd Life Guards, F.C.S., F.G.S., Topographical Staff. Royal 8vo., cloth boards. Price 2*s*. 6*d*.

Part V.—INFANTRY.
Compiled by CAPTAIN MARTIN PETRIE, Topographical Staff. Royal 8vo., cloth boards. Price 5*s*., with Plates.

Part VI.—COMMISSARIAT.
Compiled by LIEUT. H. M. HOZIER, 2nd Life Guards, F.C.S., F.G.S., Topographical Staff. Royal 8vo., cloth boards. Price 1*s*. 6*d*.

Part VII.—HOSPITAL SERVICE.
Compiled by CAPTAIN MARTIN PETRIE, Topographical Staff. Price 5*s*., with Plates.

SAPPERS' MANUAL: Compiled for the Use of Engineer Volunteer Corps. By Major W. A. FRANKLAND, R.E. Profusely Illustrated. Demy 16mo., leather, with clasp. Price 2*s*.

TRANSPORT OF SICK AND WOUNDED TROOPS: A Treatise on. By Surgeon General T. LONGMORE, C.B., Honorary Surgeon to Her Majesty; Professor of Military Surgery in the Army Medical School; Corresponding Member of the Imperial Society of Surgery of Paris, &c., &c., &c. Illustrated by nearly 200 Woodcuts. Royal 8vo., cloth boards. Price 5*s*.

PRICED VOCABULARY of all Stores used in Her Majesty's Service, and provided by the Control Department, Clothing excepted. War Office, Pall Mall, 1st November 1871. Crown 16mo. Price 4*s*.

NOTES ON AMMUNITION.—(Second Edition.)—Corrected up to *July* 1873. By Major BARLOW, R.A. Royal 8vo., 112 pp., with Plates, in paper covers, 2*s*., or in cloth boards, 3*s*.

AMMUNITION: A Descriptive Treatise on the different Projectiles, Charges, Fuzes, Rockets, &c., at present in use for Land and Sea Service, and on other War Stores manufactured in the Royal Laboratory. Ammunition for Rifled Ordnance. By Capt. CHARLES ORDE BROWNE, Royal Artillery, Captain Instructor, Royal Laboratory, Woolwich. The right of Translation reserved. (Entered at Stationers' Hall.) Printed by Order of the Secretary of State for War. September 1870. Royal 8vo. **Part II.—continued.** Price 2*s*. 6*d*.

RIFLED ORDNANCE: A Text Book of the Construction and Manufacture of, in the British Service. By Capt. FRANC. S. STONEY, Royal Artillery, Assistant Superintendent Royal Gun Factories, and Lieut. CHARLES JONES, Royal Artillery, Instructor Royal Gun Factories. Printed by Order of the Secretary of State for War. Corrected up to November 1872. Royal 8vo., with numerous Plates, in paper cover, price 3*s*. 6*d*., or cloth boards, 4*s*. 6*d*.

SIEGE OF SEBASTOPOL: Journals of Proceedings connected with. In 4 vols, 4to., price 4*l*. 4*s*., including Maps and Plans. Or in separate volumes:—Engineer Operations, Sir H. JONES, 1*l*. 6*s*. Engineer Operations, Major ELPHINSTONE (with Maps), 2*l*. 10*s*. Artillery Operations, Sir R. DACRES, 10*s*. Other Maps and Plans, 20*s*.

EXPEDITION TO ABYSSINIA: Record of. Compiled, by order of the Secretary of State for War, by Lieut.-Col. TREVENEN J. HOLLAND, C.B., Bombay Staff Corps, and Captain HENRY HOZIER, 3rd Dragoon Guards. In 2 vols. and case of Maps, cloth, 4*l*. 4*s*.; half morocco, 5*l*. 5*s*.

SANITARY STATE OF THE ARMY IN INDIA: Report of the Commissioners appointed to inquire into. With Abstract of Evidence, and of Reports received from Indian Military Stations. Royal 8vo., 606 pp., with Maps, &c. Price 6*s*.

IRELAND. Hand Book of Railway Distances, compiled by direction of the Secretary of State for War from the Official Returns, &c. of the various Railway Companies. With a Map. By WALTER WESTCOTT BROWNING, of the War Office, and revised by the Railway Clearing House, Dublin. War Office, Pall Mall, 31st October 1868. Cloth, price 6*s*.

LIST OF WORKS

PREPARED AT THE

TOPOGRAPHICAL & STATISTICAL DEPARTMENT OF THE WAR OFFICE.

TRAINING OF TROOPS, Regulations for, for Service in the Field, and for the Conduct of Peace Manœuvres. Translated from the German, by Captain E. BARING, R.A. Royal 8vo., 84 pp., with Plans. Price 2*s.*

ELEMENTARY TACTICS of the Prussian Infantry. Translated from the German, by Captain E. BARING, R.A. Authorised Edition. Royal 8vo., 60 pp., with Plans. 2*s.*

RULES for the CONDUCT of the WAR GAME. Compiled by Captain E. BARING, R.A. The Box of Men, &c., can be had for 6*l.* 6*s.*, and 15 Maps, mounted and coloured, for 6*l.* Royal 8vo., with Plans. Price 2*s.*

MILITARY REPORTS: Addressed to the French War Minister by Colonel BARON STOFFEL, French Military Attaché in Prussia. 1866–1870. Translated by Lieut.-Col. HOME, C.B., R.E. Royal 8vo. Price 8*s.*

REFORMS IN THE FRENCH ARMY. Part I.—The Law of Recruiting. Translated by Lieut.-Col. HOME, C.B., R.E. Royal 8vo., 104 pp., stiff paper cover. Price 1*s.* 6*d.*

——— **PART II.—GENERAL ORGANIZATION. Translated by** Major C. B. Brackenbury, R.A. Price 2*s.*

THE FRANCO-GERMAN WAR, 1870-71. Authorised Trans-lation. First Part:—History of the War to the Downfall of the Empire. Translated from the German Official Account by Capt. F. C. H. CLARKE, R.A.

First Section:—The Events in July.
Royal 8vo., stiff paper cover, with Plan. Price 3*s.*

Second Section:—Events to the Eve of the Battles of Wörth and Spicheren.
Royal 8vo., stiff paper cover, with Three Plans. Price 4*s.*

Third Section:—The Battles of Wörth and Spicheren.
Royal 8vo., stiff paper cover, with Two Plans and Three Sketches. Price 5*s.*

Fourth Section:—Advance of the Third Army to the Moselle, &c.
With one Plan and Seven Sketches. Price 4*s.*

Fifth Section:—In the Press.

CAMPAIGN OF 1866 IN GERMANY. Compiled by the Depart-ment of Military History of the Prussian Staff. Translated into English by Colonel VON WRIGHT, Chief of the Staff VIII. Prussian Corps, and Capt. HENRY M. HOZIER, Assistant Controller. Price 1*l.* 1*s.*, in one vol. Royal 8vo., cloth boards, with a Portfolio of Plans.

THE ARMED STRENGTH of RUSSIA. Authorised Translation from the German. In Royal 8vo., 218 pp., with Plans. Price 7*s.*

THE ARMED STRENGTH OF AUSTRIA. By Capt. W. S. Cook, 22nd Regiment. Royal 8vo. Part I. 180 pp., paper covers. Price 10*s.* 6*d.*

——— **PART II.**—261 pp., paper covers. Price 11*s.* 6*d.*

A PRÉCIS OF MODERN TACTICS. Compiled by Lieut.-Col. Robert Home, C.B., R.E. In Royal 8vo., 244 pp., with 26 Plans. Cloth boards. Price 8*s.* 6*d.*

LONDON:
Printed under the Superintendence of H.M. Stationery Office,
AND SOLD BY
W. CLOWES & SONS, 13, Charing Cross; HARRISON & SONS, 59, Pall Mall;
W. H. ALLEN & CO., 13, Waterloo Place; W. MITCHELL, 39, Charing Cross;
LONGMAN & CO., Paternoster Row; TRÜBNER & CO., 57 & 59, Ludgate Hill;
STANFORD, Charing Cross; and H. S. KING & CO., 65, Cornhill;
Also by GRIFFIN & CO., The Hard, Portsea;
A. & C. BLACK, Edinburgh; D. ROBERTSON, 90, St. Vincent St., Glasgow;
ALEX. THOM, Abbey Street, and E. PONSONBY, Grafton Street, Dublin.



